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TECHNICAL ASSISTANCE PROGRAMMES AND THEIR SUPPORT

THE fourth annual report of the Consultative Committee for Co-operative Economic Development in South and South-East Asia was published* in Britain about a month after the meeting of the Committee in Singapore. A major issue at that meeting was the decision whether, after the conclusion in 1957 of the first six-year period, the Colombo Plan should continue for a further six years or on an annual basis. On that question the report gives plenty of evidence as to the value of some period greater than one year to enable effective technical and economic plans to be made, without exactly conveying the concern of the delegates over the difficulties resulting from an annual increment of population of 1·6 per cent and the failure of food production to keep pace with this increase in an area already containing one-quarter of the population of the world. The report also provides further background to the report on technical co-operation in the area, issued in August by the Council for Technical Co-operation in South and South-East Asia (see *Nature*, 175, 267; 1955).

On technical assistance the report itself adds but little to the latter report. Progress in this field has matched the progress in economic development in the area, and during 1954–55 more trainees were sent abroad under such schemes and more experts and special equipment supplied to the area than in any previous year, while the amount of technical assistance provided within the area is also increasing. Since the various schemes of technical assistance started, 7,189 training awards have been made and 3,715 experts have been supplied to countries of the area; of these the United Kingdom has made 853 awards and supplied 157 experts. The United States has made 3,025 training awards and supplied 949 experts, and besides utilizing the services of consultant firms in management and engineering, these United States programmes make much use of inter-university contracts, usually for a three-year period, involving interchange of staff between educational institutions in the United States and in the host countries, and also providing training institutions in the United States universities for candidates nominated by these institutions. At the end of August 1955, twenty-three such contracts were in operation in eight member countries, and like other programmes, those of the United States seek to foster activities which can be continued by the recipient country itself. It should be noted also that the United States is now attempting to relieve the chronic shortage of technicians for the Technical Assistance Programme by direct recruitment from the universities.

A feature of the technical assistance programmes of the past two years is the increasing emphasis on the development of training facilities within the Asian countries themselves, and particularly for the middle and lower technical grades. While, moreover, the co-operating governments now have a better idea of what forms of assistance and what type of experts or training facilities the respective agencies can best provide, it is a major and continuing task to ensure co-operation between governments and agencies responsible for technical assistance schemes. Nevertheless, progress is clearly being made, and a sound basis has already been provided on which technical assistance may become of even more significance in the economic development and welfare of the countries of the area in future.

One such direction is nuclear power. It was announced at the Singapore meeting that the United States had offered to establish in south or south-east Asia a centre for nuclear research and training, which will include a research reactor and a small power reactor, and that Canada and India are now working out details of an agreed plan for a research reactor in India. Both establishments will be available also for the use of scientists from other centres. The Canadian delegate announced that Canada would provide Burma with a cobalt beam therapy unit, and that she wished to receive as many Asian scientists as her facilities allowed for research and training in nuclear physics. Afterwards, the United Kingdom and India, as a result of discussions between the Atomic Energy Authority and the Indian Department of Atomic Energy, announced an agreement providing for close co-operation and mutual assistance in developing the peaceful uses of nuclear energy. Members of the staff of the two bodies are to consult and work together on mutually agreed topics, and under the agreement Britain will provide India with enriched uranium fuel for the reactor, offered to India by Canada under the Colombo Plan and now under construction at Bombay.

It is desirable that the magnitude of the assistance which Britain is able to offer in this field should be fully appreciated both in Britain itself and overseas. The reactor under construction at Bombay is intended primarily for research purposes; and in this field Britain is particularly well placed to offer assistance, though in the present man-power situation it is a matter of nice judgment how far that assistance can be given by supplying experts to India or other Colombo Plan countries, as against offering training facilities at Harwell and elsewhere, or exporting nuclear plant. Such developments are as important for Britain's own industrial future as they are for the development of those areas of the world where nuclear energy may well play an essential part if natural resources are to be opened up in step with expanding population.

Nuclear energy is one of the more spectacular aspects of the developments which technical assistance makes possible; but it should be seen in proper perspective, not only in relation to our available resources of materials and man-power, but also to technical assistance generally and Colombo Plan developments as a whole. Perhaps even more than the reports

* Colombo Plan Technical Co-operation Scheme. Report 1954–55. Pp. 30. (London: H.M. Stationery Office, 1955.) 1s. 3d. net.

coming from the Consultative Committee for the Colombo Plan, that of the Technical Assistance Board of the United Nations brings out the extent to which technical assistance consists mainly in the multiplication of little schemes rather than in fostering large international projects. From one point of view, the United Nations organization and the Council for Technical Co-operation under the Colombo Plan can be regarded as essentially recruiting organizations for drawing on the experts of the specialized agencies or supporting countries and selecting students from the backward countries to be sent to Western universities and colleges.

In 1954, for example, the Technical Assistance Board had 1,584 of its specialists at work in seventy-one countries and made awards to 1,524 Fellows from eighty-six countries. On all this work less than £7 million was spent in 1954, to which Britain contributed £650,000. This share is to be increased to £800,000 in 1956, and at the Singapore meeting Lord Reading emphasized the value which the British Government attached to the technical assistance part of the Plan and indicated that the purpose of the new grant is to increase the British aid to non-Commonwealth countries which have not been members of the Colombo Plan from the beginning and which would not benefit from Colonial Development and Welfare Funds. Moreover, it seems but common sense, where the exchange of experts and provision of training places is so important, to make some reasonable provision for continuity from year to year, so that planning ahead and continuous training are possible. That, and the elimination of as many obstacles as possible to the movement of experts, seem to be the great needs. It is therefore satisfactory to find a disposition on the part of the British Government to lend its support to the idea of continuity, and also to note in the United States some decrease in the difficulty which foreign scholars have experienced in the past in securing entrance visas. Whether or not it is due to the determined efforts of the Federation of American Scientists, which presented a report on the subject last May, no real difficulties were experienced by the participants at the international meeting on arid lands, research and utilization arranged by the American Association for the Advancement of Science last April. Participants were selected entirely for their scientific competence, and, according to *Science*, the State Department co-operated efficiently.

It is at such points as these that the vigilance and help of professional associations can make a valuable contribution to the effectiveness of technical co-operation. Thus it may be recalled that the Federation of British Industries, in a report issued in 1954, emphasized the importance of continuity of budgeting and of giving the fullest possible support that the man-power situation in Britain would permit. Technical assistance is indeed one element for which any expansion in technical and technological education in Britain should provide. Similarly, the improvement of means of communication in scientific and technical matters, whether in the means by which such information is disseminated or in the extent of co-operation between appropriate government departments, is another way in which the provision of technical assistance could be made more effective and the attraction of the indispensable foreign capital made easier. The fourth annual report of the Consultative Committee referred to earlier notes; for example, the establishment of the Ceylon Institute of Scientific and Industrial Research to improve technical processes in industry, to advise on matters affecting the utilization of Ceylon's internal resources, to foster training and the dissemination of technical information, and to co-operate with government departments and the university and other technical organizations in promoting scientific and industrial research.

Where, as in India and Ceylon, such bodies exist and are well staffed and efficiently administered, technical assistance is greatly facilitated. There are, however, wide differences in the technical and administrative standards of the different under-developed countries, as well as in their economic situations. The report emphasizes that, while all the countries in South and South-East Asia depend largely and at crucial points on imports for their development projects, there are wide differences from country to country in such factors as the diversity and stability of exports, the dependence on imports for current consumption, capital inflow or outflow, and the size of reserves in relation to turnover. Again, the countries of the area differ widely in the degree to which they have been able to organize their development. Considerable progress has been made, but all of them face formidable difficulties in collecting the complex technical, economic and financial details on which plans must be based, and creating or expanding the necessary administrative and executive organization.

Largely these are problems of personnel, in which the Technical Co-operation Scheme and other arrangements for technical assistance are invaluable; but in spite of the progress that has been made, this review indicates that the tasks that still remain may well prove even harder, and call for a proportionately greater effort if pace is to be kept with a population increase in the area as a whole estimated at about 10 million persons a year. The review does not encourage facile optimism; it sets the difficulties and problems in the forefront, challenging the sharing of experience in the search for solutions. None the less, it demonstrates that the idea of co-operative effort, both within each country and between countries, is spreading ever more widely and deeply. The British contribution to the Colombo Plan is only a part of a contribution to the development of the more backward areas of which Britain has a right to be proud.

An article on some problems in under-developed areas which Mr. E. W. Golding contributed to the June 1955 issue of *Impact* shows very clearly how closely related are the factors contributing to the effectiveness of technical assistance to those on which scientific and technical advance in general depend. Besides the educational, administrative and like problems which hinder development in the backward areas, there is the exchange of information;

Mr. Golding stresses the vital importance in this connexion of fellowships and studentships which permit free movement of scholars, students, scientists and all kinds of experts from universities and colleges, research institutions and government research stations or laboratories in one country to those in another. It is not simply that the exchange of technique and information is thereby facilitated: international understanding and good-fellowship are likewise promoted, and this can further the better hospitality now afforded the essential foreign capital by most of the Asian countries which are members of the Colombo Plan. The possibilities of agreement on development schemes for international sponsorship are also increased, as Mr. Golding points out, by international meetings such as the symposia organized by the Unesco Advisory Committee on Arid Zone Research in a different area each year. Forums such as these can also assist arrangements for regular exchanges of information on the progress of the schemes and for demonstration visits. What needs to be realized is that scientific, technical and economic data are the indispensable basis for any sound development plan, and that informal as well as official contacts can greatly assist the acquisition of the information needed by the Colombo Plan countries and the backward areas—and even many advanced countries. By pressing resolutely but imaginatively for the removal, as far as possible, of all barriers to the exchange of information, the dissemination of knowledge and the movement of the scholar and scientist and student, the scientist could do something tangible to promote the great purposes for which the Colombo Plan and similar schemes were conceived.

GENETICS AND BRITISH MOTHS

Moths

By Dr. E. B. Ford. (New Naturalist Series: a Survey of British Natural History.) Pp. xix+266+56 plates. (London: William Collins, Sons and Co., Ltd., 1955.) 35*s*. net.

GENERALIZING, this is an excellent book. Its approach is the same as in Dr. E. B. Ford's well-known "Butterflies" in the New Naturalist series, and it is really a sequential volume, there being constant page-references back to "Butterflies". The book is primarily concerned with biological phenomena occurring in the British moth fauna that can be studied and are likely to contribute to the general stream of biological knowledge; it is not a collector's identification book. This is intentional; for, as Dr. Ford states on p. 19, the "entomologist or ornithologist thinks in terms of insects or birds. That was the right way to think when biology was being developed in the past: it is becoming wrong today". This is a curious statement coming from Dr. Ford. So many of the problems that are his concern in the text could only have come to light by means of old-fashioned field-work and the amassing of cabinet collections. Furthermore, the text seethes with evidence that Dr. Ford is himself an extremely active field collector. To bring further problems to light, more collecting will have to be done; surely the ordinary systematic collector might get the status of co-operator and not merely handmaiden. One fears that the latter status is indicated by Dr. Ford's words (p. 19) when he states that he directs "attention to these aspects of the subject which have been neglected in the Lepidoptera, in the hope that entomologists and collectors may be able to supply the data on them which are so badly needed".

A brief chapter on structure and physiology is followed by four chapters on genetics, genetical phenomena and theory, and especially those phenomena seen in wild populations of British moths when these are taken into the laboratory for study or worked on in the field. This is a topic that Dr. Ford has made his own, and these chapters on moth genetics are authoritative. Then follow chapters on polymorphism, on dispersal, and on protective devices. The wealth of illustrative material that Dr. Ford has found in the British moth fauna almost surprises one.

Chapter 8 is a brief intrusion on injurious moths, after which the reader is taken back, through geographical distribution (Chapter 9) and types of habitat (Chapter 10), to relict faunas (Chapter 11), geographical races (Chapter 12) and a most useful chapter on melanism, industrial and otherwise. This last chapter suggests that entomologists should make a serious effort to conduct long-term studies of the moth faunas in the neighbourhood of some of the new industrial centres springing up in Great Britain. Entomologists overseas in the Dominions and elsewhere might do likewise.

The final chapter, on evolution, is again remarkable for the way in which Dr. Ford is able, in discussing this topic, to illustrate it with numerous examples from the British moth fauna. There is an appendix on the classification of moths dealt with in the book. This classification follows, in the main, that of Kloet and Hincks[1], and it is possibly unfortunate that, though more modern, it differs from those of Meyrick[2] and South[3], which are the identification books that readers are most likely to use. There are a glossary of six pages, two pages of references, some distribution maps, and an index that seems to be adequate.

Such criticism as one might level at the book seems, on second thoughts, to be criticism of the editors and, possibly, of an undisclosed lepidopterist whom they may have employed as a sub-editor. On Pl. 20, Fig. 1 is a light-coloured specimen of the great brocade, *Eurois occulta*; Fig. 2 is a dark specimen of the same species. The legend states that the first comes from Rannoch and the second from Essex. In the text, on p. 80, it is correctly stated that the dark form is found in Scotland and the light in the south of Britain. On Pl. 17, Fig. 7, one feels almost certain that the specimen figured is not the silky wainscot, *Chilodes maritima*, as stated.

The colour of inks used in printing the coloured plates should be more carefully controlled by the editors. On Pl. 31 the purple hue on the moths would certainly prevent some of the species from being recognized from the figures. There is an unnaturalness in the green coloration in some places, and the coloration of some of the caterpillars seems a little untrue. An example is the elephant hawk caterpillar (Pl. 21, Fig. 4); but possibly this is in fact a specimen of the greenish form sometimes encountered, though there is no statement in the text or legend that this is so. In the copy before the reviewer, four colour plates (Pls. 6, 7, 18, 19) are off-register: 6 and 18 slightly, 7 and 19 to an extent

that makes the subjects very fuzzy. The goat moth caterpillar shown in Pl. 6, Fig. 1, looks moribund, but perhaps it is just getting ready to pupate. The black-and-white photographs are of uniform excellence and make one feel that there is a need to discriminate a little bit in the choice of subjects best suited to colour or to black-and-white photography and reproduction when information is to be conveyed by eye to the reader. Some of the colour figures of small caterpillars tell one very little indeed.

There is no point in combing the text for trivial errata; but one cannot help wondering how the author, or the editors, at least two of whom are well versed in general taxonomic theory, allowed the family Lasiocampidae (the eggars) to stray out of the super-family Lasiocampoidea into the next super-family Bombycoidea, though they might be forgiven for not realizing that the Endromididae (*sic pro* Endromidae) of the super-family Bombycoidea were out of place in the super-family Lasiocampoidea (p. 237).

JOHN SMART

[1] Kloet, G. S., and Hincks, W. D., "A Check-list of British Insects" (Stockport, 1945).
[2] Meyrick, E., "A Revised Handbook of British Lepidoptera" (Watkins and Doncaster, London, 1927).
[3] South, R., "The Moths of the British Isles", 2 vols., revised by H. M. Edelston (Warne, London, 1939).

AN INTRODUCTION TO PRECAST CONCRETE

Precast Concrete

By Dr. Kurt Billig. Pp. xvi+341. (London: Macmillan and Co., Ltd., 1955.) 32*s*. net.

THE art of precasting concrete has given rise to an established industry producing staple things like blocks, tiles, floor beams and parts for small structures, where problems are in the nature of factory production-engineering, and a more nebulous practice involving the more sophisticated extension of the art to large structures, bridge girders, and so on, which demand the designer's closest attention if the choice of the medium is to be economically justifiable. The whole industry has been profoundly affected within the past decade by the technique of prestressing, which has developed into a competitor with structural steel.

To deal with the whole subject in a comprehensive manner would demand a writing of considerable dimensions. Dr. Kurt Billig has mentioned most aspects of precast concrete: those forming the basis of organized industry are treated summarily, and attention is given chiefly to the structural uses of reinforced and prestressed precast concrete. In attempting to cover so large a field in a book of about three hundred pages, it is not surprising to find that frequently the treatment is hurried. The aim appears to be the stimulation of interest in the potentialities of structural precast concrete, rather than to present a text-book for the factory engineer or designer. Some 40 per cent of the material has appeared elsewhere; almost the whole of Dr. Billig's earlier work, "Structural Precast Reinforced Concrete", published by the Cement and Concrete Association in 1947, has been reproduced with scarcely any alteration, except that the sections have been re-shuffled to suit the larger work. Dr. Billig has also drawn on his book, "Prestressed Concrete".

The book is divided into four parts: Part 1 deals with design and production; Part 2 with the precast units themselves; Part 3 with joints; and Part 4 with structures in which precast concrete has been used. One might expect difficulties in avoiding overlapping with this breakdown of the subject, but on the whole Dr. Billig handles his matter satisfactorily. There are some cases of repetition, however, and occasionally the meaning becomes elusive, as, for example, "The work done during prestressing levels the discrepancy between the absolute values of the compressive and tensile resistances of the concrete and between the ultimate strains in tension of the steel and the concrete". One or two points seem to receive disproportionate attention: a discussion on 'æsthetics' labours the old problem whether concrete, which looks like stone, can rightly be placed in a position of tension, and six systems are described which use concrete spread on hessian or jute fabric.

References are quoted at the ends of a number of chapters, but Dr. Billig has chosen not to annotate the text in any way to indicate what he may have drawn from these works. This is unfortunate since, for many readers, it defeats the object of such references.

Dr. Billig is at his best when writing about industrial structures, and one wishes that he had gone into greater detail and given more examples. Many of the examples invite the comparison of precast reinforced concrete with *in situ* concrete. In his chapter on "Efficiency", Dr. Billig has attempted to indicate that the assessment of prestressed concrete should be by comparison with structural steel. That there is a place for both normally reinforced and prestressed precast concrete in the scheme of things seems to have been demonstrated, but what is best done by one or the other does not emerge at all clearly.

T. WHITAKER

ZOOLOGICAL LITERATURE OF 1952

The Zoological Record

Vol. 89 (Being the Records of Zoological Literature relating chiefly to the year 1952). Edited by G. Burder Stratton. Pp. vi+1450. (London: Zoological Society of London, 1955.) 120*s*.

ZOOLOGISTS throughout the world owe a special debt of gratitude to the Zoological Society of London for continuing to produce each year the "Zoological Record". Its compilation is a very heavy task and the general editor, Mr. G. Burder Stratton, and the sectional editors and recorders, in preparing the lists of titles of all zoological publications appearing during the particular year under consideration, have to search through hundreds of scientific periodicals in all languages. In addition, the material is classified so as to be of use not only to taxonomists, but also to those engaged in any of the many specialist branches of the subject, such as structure (including histology and cytology), physiology, evolution and genetics, development, reproduction and sex, ecology and habits, geographical distribution, and palæontology and geological distribution. The amount of time saved by having this information thus summarized by specialists in the subjects can only be fully realized by those who have tried to search through the literature on any particular group of animals, or species, previous to 1864 when the "Zoological Record" was founded.

The present volume relates chiefly to the literature of the year 1952, but unfortunately does not include the sections dealing with Vermes and Trilobita, which did not arrive in time. It is hoped, however, that the literature for both 1952 and 1953 of these two groups will be included in Vol. 90.

The other sixteen sections give a rough indication of the work going on in different groups of the animal kingdom, and, as would be expected, Insecta heads the list with a total of 3,332 titles. The next largest section is Aves with 1,696 titles, and other large groups include Mammalia, 1,282; Protozoa, 1,194; Pisces, 1,115; Amphibia and Reptilia, 1,090; and Mollusca, 968. Finally, there is a section giving a list of 1,883 new generic and subgeneric names recorded during 1952, which is made up as follows: Protozoa, 94; Porifera, 12; Coelenterata, 86; Echinoderma, 26; Brachiopoda, 22; Bryozoa, 51; Mollusca, 140; Crustacea, 50; Arachnida, 139; Insecta, 1,107; Protochordata, 1; Pisces, 75; Amphibia, 7; Reptilia, 29; Aves, 2; Mammalia, 42.

It may be recalled that in 1954 the Zoological Society of London authorized a reprinting of Vols. 1–20 of the "Zoological Record", which had been out of print for many years. The success of this venture has been such that the reprinting of further volumes which have become out of print is now under consideration, and any such issues would be welcomed by all zoological libraries and departments with incomplete sets of this invaluable publication.

EDWARD HINDLE

COLORIMETRIC METHODS IN CHEMICAL ANALYSIS

Colorimetric Methods of Analysis, including Some Turbidimetric and Nephelometric Methods

By Dr. Foster Dee Snell and Dr. Cornelia T. Snell. Vol. 3, Organic—1; pp. viii+606; Vol. 4, Organic—2; pp. vii+676. Third edition. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1953–54.) 93*s.* 6*d.* net each vol.

THE authors of this well-known treatise on colorimetry have set themselves an almost herculean task in producing a third edition. The organic and biological material covers such a wide field that it has necessitated two volumes instead of the single volume originally contemplated. Vol. 3 comprises nineteen chapters commencing with a very brief but important introductory one, which explains that "every possible method of condensation has been applied" in order to include such a large number of individual substances. The division of this wide variety into logical sequence and chapters has been difficult. Whereas all the hormones are dealt with in a single chapter, it has been found necessary to spread the vitamins between the two volumes in six chapters. This difficulty also applies to pigments, weed-killers, insecticides and plant growth-regulating substances. In order to make easy reference to a given compound, each substance in the subject index is listed as far as possible both under its systematic name and also its trade or recognized trivial name.

Several methods are sometimes described for one substance, depending on the need to determine milligram or microgram quantities. The authors have described, as far as possible, the substances known to interfere with a particular determination and have included methods for their removal. The nineteen chapters include hydrocarbons, alcohols, esters, phenols, the sugar and glucoside family, aldehydes and ketones, the acid family (except amino-acids), sulphur and halogen compounds. Where such a wide field has been covered it seems unjust to want more; but I, and no doubt others too, regret that a little space could not be found for some important subjects. In the chapter on alcohols and their esters, it is disappointing that more space has not been found for the determination of alcohol in blood and urine, as this subject has assumed much medico-legal significance in recent years.

Glycerol, in view of its commercial importance, seems worthy of fuller treatment. On the other hand, sixteen pages have been devoted to thiamine (vitamin B_1), since the vitamin may occur in so many materials, including pharmaceutical products, foods and biological specimens. There are no less than fifty-eight references to the literature for this one substance. Similarly, sulphonamides, which have assumed such prominence in medicine, have been allocated thirteen pages and seventy-three references. For the sake of completeness, methods which are scarcely colorimetric have been included; for example, in the section on fats and oils, the conjugated and non-conjugated constituents of fats and oils are determined by an isomerization method, and readings taken by spectrophotometer in the ultra-violet region. Included in the chapter on halogen compounds are some of the more important insecticides and their determination in foods, milk, biological tissue and spray residues. While the specialist in this subject will need more information than can be given in such a general treatment, the authors are to be congratulated in collecting such a wide range of references.

Vol. 4 deals almost entirely with naturally occurring substances in its sixteen chapters. These range from amines and amino-acids to sterols, hormones, alkaloids, enzymes, antibiotics and pigments. Methods for the determination of quaternary ammonium compounds and domestic and textile detergents in effluents and sewage would have been welcomed by water consultants, since the presence of these substances constitutes an increasing difficulty in water purification. The final chapter describes methods for the measurement of the colour of liquids. The authors have confined themselves almost entirely to methods adopted by the Association of Official Agricultural Chemists, the American Public Health Association, and the American Oil Chemists Society. This is logical for American readers, but others may require more general methods. As stated in Vol. 1, the authors considered the use of the C.I.E. system of colour measurement outside the scope of their treatise, but it is hoped that a wider use of the system will merit its inclusion in a future edition.

In the four volumes of the complete work a surprising variety of materials and methods has been dealt with, and very few which reach the consultant omitted. This greatly enlarged edition should find a place in all laboratories using colorimetric methods of estimation. Although the specialist in each subject is unlikely to find methods which are new to him, the four volumes contain the most complete collection of colorimetric determinations I have yet encountered. The volumes are well printed and illustrated and are reasonably free from misprints, and the index to each volume is full and carefully prepared. J. KING

Primates

Comparative Anatomy and Taxonomy. 2: Haplorhini: Tarsioidea. A Monograph by W. C. Osman Hill. (Edinburgh University Publications—Science and Mathematics, No. 3.) Pp. xx+347+14 plates. (Edinburgh: At the University Press, 1955. Agents: Thomas Nelson and Sons, Ltd.) 63*s*.

DR. W. C. OSMAN HILL has lost little time in bringing out the second part of his monumental review of the Primates, of which the first, on the Strepsirhini, was published in 1953 (see *Nature*, 172, 880; 1953). The present volume deals with the Tarsioidea, which Osman Hill, following Pocock (but contrary to Gaylord Simpson), accepts as a sub-order of the Haplorhini. This division of the Primates also includes the sub-order Pithecoidea, comprising the monkeys, apes and man. Osman Hill appreciates that the Tarsioidea differ considerably in many parts of their anatomy from the Pithecoidea, but justifies his acceptance of the earlier classification by appealing to the difficulty of classifying *Tarsius* with the lemurs.

The volume is essentially a monograph on *Tarsius spectrum*, but begins with a general review of the literature on the systematic anatomy of the Haplorhini, which includes some observations on reproductive physiology and behaviour. The middle section of the book, some hundred and thirty pages long, deals specifically with the anatomy of *Tarsius spectrum*. This part of the work incorporates a number of original observations. The final sixty pages or so summarize what has been published about the palæontology of the sub-order. The book is well illustrated.

In a review dealing with a field as wide as that which Dr. Osman Hill is trying to cover, it is inevitable that some literature should be overlooked and that reference to certain authoritative views should be lacking; such omissions are especially evident in the section dealing with the general biology of the Haplorhini. In view of the limited amount of our knowledge, it is also not surprising that the section dealing with the embryology, psychology and reproductive physiology of *Tarsius spectrum* occupies only fifteen pages as compared with the hundred or so devoted to its anatomy. Disproportions of this kind are a challenge to future workers. Dr. Osman Hill's work is sufficiently encyclopædic to serve, like the volume which preceded it, as a reference book and summary for all future students who are likely to concern themselves with the phylogenetically important group of Primates which *Tarsius* represents.

S. Zuckerman

A Textbook of Radar

Edited by Dr. E. G. Bowen. (A Collective Work by the Staff of The Radiophysics Laboratory, C.S.I.R.O., Australia.) Second edition. Pp. xiii+617+41 plates. (Cambridge: At the University Press, 1954.) 45*s*. net.

THIS second edition of a collection of articles on various aspects of radar by the staff of the Radiophysics Laboratory of the Commonwealth Scientific and Industrial Research Organization, Australia, is now published by the Cambridge University Press, under the editorship of Dr. E. G. Bowen. The book deals with the fundamental principles of radar, and its application to war, to navigation and to various problems of physical science. In the first two of these, the present edition does not differ greatly from the first, though the section on military applications has been curtailed. The section on application of radar to physical science has been expanded and now deals with such topics as ionospheric research, moon echoes, meteor trails, meteorology and radio astronomy. This is a welcome addition which helps to bring the subject up to date as regards non-military applications.

The book succeeds in compressing into a single volume a large amount of material, but is still quite readable by the beginner. As editor, Dr. E. G. Bowen has brought a certain amount of unity into what might have been just a collection of papers. Clearly, it cannot replace the specialist volumes on war-time radar research issued by the Radiation Laboratory in the United States or the Modern Radio Techniques Series published by the Cambridge University Press, but will serve as an excellent introduction to these. The practice of the first edition of quoting unpublished reports has fortunately been discontinued to a large extent, and many more references to published work are given. The index of authors is, however, very inadequate for a work of this sort, which should prove valuable for reference as well as for initial instruction.

R. A. Smith

Frontier to Space

By Eric Burgess. Pp. xvi+174+26 plates. (London: Chapman and Hall, Ltd., 1955.) 21*s*. net.

IN "Frontier to Space" Mr. Eric Burgess gives a survey of recent research on the terrestrial upper atmosphere, paying special attention to the results obtained with the aid of rockets. Most of these results were reported at the conference held in Oxford in the summer of 1953 under the auspices of the Gassiot Committee of the Royal Society. Though they have been published in full in "Rocket Exploration of the Upper Atmosphere" (Pergamon Press, Ltd., London) the summary presented by Mr. Burgess is to be welcomed. Sufficient detailed references to the original literature are given to make the book a useful introduction to the subject. Many interesting and instructive diagrams and plates are included.

The student must not accept all that is said uncritically, for the author sometimes quotes out-of-date views. For example, it is misleading to state (p. 79) that "The growth and decay of the ionized atoms and molecules [in the ionosphere] causes a glow to be emitted which appears as the day and night airglows"; or to state (p. 82) that "It is nowadays thought, therefore, that the ionization of oxygen is the most likely mechanism [for the production of *D*-region ionization]". In spite of occasional defects of this nature, the book can be recommended. The educated scientific public should be able to read most of it without difficulty and should find it stimulating. The production is excellent.

D. R. Bates

The Theory of Stereoscopic Transmission and its Application to the Motion Picture

By Raymond and Nigel Spottiswoode. Pp. xii+179. (Berkeley and Los Angeles: University of California Press; London: Faber and Faber, Ltd., 1953.) 42*s*. net.

AMONG the most popular items at the 1951 Festival of Britain were the three-dimensional films shown at the Telekinema. A year or two later, 3D had taken the film industry by storm, and we became familiar with 'Polaroid' viewers, eye-strain, some curious space distortions and, from time to

time, some quite remarkable and beautiful stereo-cinematic effects. All this has now vanished, and we are left with wide-screen techniques instead.

During these years the Spottiswoode brothers were the leading enthusiasts in Great Britain, and they give in this book an account of the theory of stereoscopic cinematography in a form which they have found by experience to be most helpful. Perhaps some people may be surprised to learn that anything serious in the way of a theory is required—Hollywood was probably taken by surprise too—but the presentation of a set of mutually consistent three-dimensional clues is no easy task.

In addition to elaborating the geometry of the binocular parallax, the book deals with the characteristics, mechanisms and methods of practical stereoscopic systems. Neither the algebra nor the terminology which the authors have used makes the book easy reading—terms like hyper-infinite and hypo-infinite systems seem designed to confuse rather than clarify the problem—yet if only the film industry could have spared the time to master the subject instead of impetuously rushing ahead, something really exciting might have emerged. The possibilities are still there.

W. D. WRIGHT

Practical Physical Chemistry

By Prof. Alexander Findlay. Revised and Edited by J. A. Kitchener. Eighth edition. Pp. xiii+364. (London: Longmans, Green and Co., Ltd., 1954.) 18*s*. net.

PROF. A. FINDLAY'S book has been a friend to teachers and students of physical chemistry for many years. It was first published in 1906 and has now reached an eighth edition. With the passage of time new interests and techniques have arisen, and books must take account of these. Dr. J. A. Kitchener has undertaken a revision which is intended to preserve the original character and at the same time bring the book up to date. Many new experiments and apparatus for performing them are described. References to literature are given at the ends of the sections.

The error of some books of this kind of giving large digressions on theory, and sketchy mentions of experiments which cannot be performed in the average student laboratory, is avoided, and the text is studiously devoted to practical work, the equations necessary for the calculation of the results being provided. In this way it has been possible to include a large amount of material—more than can be attempted in the usual practical course but giving a choice of work.

The book is an excellent guide to practical physical chemistry for the honours student, and research students should find it of great service. The revision has been very well done; and with its type reset and new figures provided, the volume is very handsome and worth double the price at which it is sold.

Birds of Eastern and North-Eastern Africa

By C. W. Mackworth-Praed and C. H. B. Grant. (African Handbook of Birds—Series 1, Vol. 2.) Pp. viii+1099+plates 54–96+photographs 7–19. (London: Longmans, Green and Co., Ltd., 1955.) 45*s*. net.

AFTER an interval of three years, this useful and excellent work has been completed by the issue of the second volume, on the same lines as its predecessor (see *Nature*, 172, 92; 1953). Among other things, one notes again with pleasure the marginal drawings and distribution maps; and the standard of reproduction of the colour plates has been much improved. The lithographed text, as before, gives the essential facts about identification, range and habits for each species and race; and there are keys to the different groups. The volume covers the passerine birds, and the number of represented forms makes it even larger than the first; the weavers occupy more than a fifth of it.

In an introductory note to this volume, the authors make a point which needs to be stressed on every suitable occasion. They refer to the many missing facts about habits, habitat and breeding which field observers have the opportunity of filling in: "It is, however, essential that they should be published. We know of many cases where such biological data are known to local residents but to no one else". This work should be a great stimulus, throughout East Africa, to the making of such observations and to recording them as contributions to available knowledge.

LANDSBOROUGH THOMSON

The Genus Nicotiana

Origins, Relationships and Evolution of its Species in the Light of their Distribution, Morphology and Cytogenetics. By Prof. Thomas Harper Goodspeed. (Chronica Botanica, Vol. 16.) Pp. xxii+536+118 plates and illustrations. (Waltham, Mass.: The Chronica Botanica Company; London: Wm. Dawson and Sons, Ltd., 1954.) 12.50 dollars.

A FEATURE of agricultural botany to-day, in both warm and temperate climates, is the intensive study that is often given to all the members of any genus that happens to contain crop plants or economic plants of some kind. How valuable this kind of work can be has been well demonstrated with the potato.

The appearance now of a most comprehensive monograph of the genus *Nicotiana*, to which tobacco belongs, is therefore very much to be welcomed. These investigations on the genus *Nicotiana* have been carried out by Prof. T. H. Goodspeed at the University of California Botanic Garden during the past thirty years and were actually initiated even earlier (in 1904). Of the sixty species known to belong to the genus *Nicotiana*, no less than fifty-six were cultivated in the Botanic Garden—a fine achievement. Five different expeditions were made to South America, and these accounted for a good deal of the living material. Actually, only two species, *N. tabacum* and *N. rustica*, are of direct economic value or yield commercial smoking tobacco at the present time. In its original distribution, before being spread by man, the genus was more or less restricted to the Americas, with a few species in Australia and some islands of the Pacific.

The author divides his monograph into six parts, the first part dealing with distribution, while successive parts deal with morphology, cytology of species, cytology of F_1 interspecific hybrids, phylesis (or evolution) and taxonomy of *Nicotiana*. Full descriptions, accompanied by line-drawings, are given for each of the sixty species. In the sections on cytology, karyotypes of all but four species and complete meiotic sequences in representative species and hybrids are illustrated. The work is a good example of modern treatment in speciation and probable evolution in plants. It should be of special interest to botanists and geneticists and to many others engaged on scientific work with tobacco or the related species.

BRITISH NUCLEAR ENERGY CONFERENCE

INAUGURAL MEETING

ON November 30, Sir Christopher Hinton, managing director of the Industrial Group, United Kingdom Atomic Energy Authority, opened the inaugural meeting of the British Nuclear Energy Conference by recalling that, although the first six years of the British atomic energy project were devoted to military requirements, a nuclear industry is now emerging. Success in this field depends upon the ability to develop and adapt existing techniques, and it was thought better that the Institutions of Civil, Mechanical, Electrical and Chemical Engineers and the Institute of Physics should jointly organize the British Nuclear Energy Conference as a permanent body for providing a forum where nuclear developments can be discussed rather than set up a new and independent society for this purpose.

Sir John Cockcroft, director of the Atomic Energy Research Establishment, gave the opening lecture, which was on "The U.K. Atomic Energy Authority and its Functions", and said that during the past three years it has been possible to turn an increasing part of the efforts of the Authority's Research and Industrial Groups to the development of nuclear power. He recalled that the Government White Paper, "A Programme of Nuclear Power", anticipated that by 1965 it might be possible to commission on a commercial basis more advanced (Stage II) reactors than the gas-cooled ones with which the programme is being started. Studies have been made of the pressurized light-water reactor and of the sodium–graphite reactor. Within the limits of the present uncertainties, there is little to choose between them on economic grounds. A choice will therefore have to be made on other grounds, since the present feeling is that the Authority's resources are adequate for the development of only one Stage II reactor in addition to the work already in hand on the fast reactor for Stage III of the programme. Development of the fast reactor will take a long time and is unlikely to make any significant contribution to electricity supply until the 1970's.

Development of a new type of reactor commences with a feasibility study by a team of physicists and engineers working with chemists and metallurgists. If the reactor is feasible, it is followed by a design study at which stage sub-critical or just-critical assemblies are built to ascertain nuclear data, and testing loops are arranged in research reactors to obtain technological data. Such a study may easily cost £300,000 a year. The annual value of isotopes produced by the Authority is now about £400,000, and this activity will be extended by the preparation of mega-curie sources from fission-fragment cæsium and strontium. These have a potentially wide field of industrial use, and their application to the polymerization of ethylene to polyethylene is already well known. A Technological Irradiation Group has been formed at Harwell to assist industry in studying these possibilities.

V. A. Pask, the chief engineer, and J. C. Duckworth, the nuclear power engineer of the Central Electricity Authority, followed Sir John with a lecture on "The Place of Nuclear Energy in United Kingdom Power Development". They pointed out that of all the countries interested in nuclear power, none has quite the same need for its quick commercial development as has Great Britain, since it is now clear that a rapidly increasing proportion of the nation's energy requirements must be supplied either from imported coal or oil or from nuclear fission. Future plant requirements were surveyed in the paper on the basis that home-produced coal for electricity might reach a maximum of 60 million tons a year by 1970 and thereafter remain at that level, and arrived at the conclusion that the nuclear capacity required to avoid import of fossil fuel would rise from 3,900 MW. in 1965 to 23,000 MW., or rather more than the present total plant capacity, by about 1980. It was noted that 3,900 MW. by 1965 is about twice the capacity proposed in the White Paper for that year, and arrangements have already been made to burn oil equivalent to about 8 million tons of coal as a stop-gap measure. The capacity of coal-fired plant must be expected to continue to rise, and by 1980 might still be nearly two and a half times the nuclear capacity. By 1980 the nuclear plant might well be carrying the whole of the base load or continuous demand.

The costs of electricity from nuclear power plants are subject to many uncertainties, not least of which is the length of time a fuel element may be left in the reactor before it must be withdrawn for reprocessing. Nevertheless, Mr. Pask and Mr. Duckworth, after a detailed consideration, have come to the conclusion that it is a reasonable expectation that net generation costs per kilowatt-hour from the earlier nuclear plants should be comparable with those from the most advanced coal-fired plants.

The prospect of competitive nuclear power with low operating costs means that this plant will carry the base load and that eventually the whole of the conventional plant will be required to operate on one- and two-shift cycles. Thus the Central Electricity Authority and the manufacturers of the conventional plants are faced with the problems of providing full operational flexibility in the large sets with advanced steam conditions which are essential if maximum economy in both capital and operating costs is to be achieved. The alternative approach is to improve the load factor. If, in the long run, nuclear power provides cheaper electricity, it should permit more attractive night tariffs than are possible at present, but a radical change is unlikely unless solutions can be found to the social problems involved in the wide adoption by industry of shift working. The fact that there would be an enhanced case for pumped-storage schemes was explained.

Nuclear plant will tend to be sited in areas where insufficient coal is mined to meet local requirements and as near as possible to major load centres. The electrical system in Britain as planned before nuclear energy became a serious proposition involves the transmission of some electricity from the coal-producing Midlands to the load centres in the south. It follows from the base-load operation of nuclear plant that transmission of electricity generated from coal will be impossible at a high load factor and therefore uneconomic. The transmission capacity now being provided for this purpose will, as time goes

by, be absorbed as inter-connexion capacity for the pooling of spare plant.

A. S. McLean, medical officer of the Industrial Group of the Atomic Energy Authority, and W. G. Marley, head of the Health Physics Division at Harwell, in their lecture on "Health and Safety in a Nuclear Power Industry", set out to put this aspect in its proper perspective. The early approaches to this subject may now seem timid and full of unrealistic apprehensions, but at the time they were perfectly justified in view of the unfortunate history of radiation in occupational disease.

Radiation injuries are often grave and are seldom reversible by treatment, but the doses causing injury are now quite well known. The workers in the Atomic Energy Authority show no abnormalities, there has been no case of radiation injury, and no new disease has made its appearance among them. In fact, no disease is peculiar to radiation. Causes cannot be determined clinically, and statistical methods are clearly necessary should questions of liability arise. The direct experience of the atomic energy project in Great Britain now extends over nearly a decade, and there has come with it a feeling of reasonable confidence that, given proper attention to adequate safeguards, work in the nuclear power industry is as safe as work anywhere else.

H. J. Grout, head of the Reactor Engineering Division at Harwell, emphasized in his lecture on "The Use of Research Reactors in Nuclear Power Development" that there is no broad background of experience yet available to guide engineers in the specification and design of nuclear power reactors. They must rely on the results of theoretical calculations and laboratory experiments, and the opportunities for subsequent inspection, repair or modification are strictly limited once the reactor has been at power and the internal structure has been intensely radioactive. It is therefore of paramount importance to ensure that the industry is backed by adequate research facilities. The purpose of research reactors is to provide both the radiation field and test-bed facilities to enable the behaviour of reactor materials and components to be studied and tested under simulated operating conditions and to obtain fundamental information in the fields of reactor physics, chemistry and metallurgy. On the fundamental side, he instanced the determination of neutron cross-sections of the various fissile materials, the metallurgical investigation of radiation damage, and the study of the effect of radiation on the rate and the equilibrium conditions of chemical reactions.

The direct application of some of the foregoing to practical designs is not easy, because many problems are so complex that the behaviour of specific systems and complete components must be studied under operating conditions. An 'active hot loop', which is an experiment on an engineering scale, would consist of a number of prototype fuel elements in a coolant system, built into an experimental hole in a reactor such that the neutron flux-level in the region would cause the elements to operate at their designed rating. A serious technical limitation of research reactors is that it is impossible to carry out accelerated tests on fuel elements without radically altering many factors which contribute to their failure.

For certain neutron cross-section measurements, a low-power reactor of stable characteristics is needed, and the pile at Harwell known as GLEEP satisfies this need. The pile BEPO at Harwell provides facilities for matters not directly connected with the power programme, such as isotope production and studies of biological systems as well as much fundamental and technological data. Its low flux ($1{\cdot}5 \times 10^{12}$ neutrons/cm.^{2}/sec.), however, limits its field of application to technological investigations. To provide the necessary facilities at a flux of 10^{14} neutrons/cm.^{2}/sec. three enriched-uranium heavy-water-moderated and cooled reactors are under construction. The piles DIDO and PLUTO will be at Harwell, and another PLUTO will be constructed at Dounreay. Each will be equipped with associated 'hot' laboratories for the examination of irradiated specimens. The rent of experimental facilities in DIDO may vary from £100 a day down to £10 a day for those in less-attractive low-flux positions.

In the discussion, emphasis was laid upon the magnitude of the task ahead both by Mr. J. Eccles, deputy chairman (operations) of the Central Electricity Authority, and by Mr. A. L. G. Lindley, of the General Electric Co., Ltd., who stressed the problem of finding sufficient men with suitable qualifications for work in this field without making undue sacrifice of effort on other work in the electrical industry. There was no suggestion from any quarter at the meeting that the problems can be regarded in any light other than that of difficulties which must be faced and overcome, and it is fitting to conclude this article with the sentiments expressed by Sir Claude Gibb, chairman of the Nuclear Power Plant Company, that it is quite certain that we can, and must, meet the nuclear power programme if Britain as we know it to-day is to survive.

THE MORPHOLOGY OF LARGE-CHAIN MOLECULES*

By Prof. CH. SADRON

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SINCE the work of Staudinger some thirty years ago, followed by that of a few pioneers such as H. Mark, K. H. Meyer, W. Kuhn, and others, it has been established that the concept of a molecule can be applied to assemblies of atoms of ever-increasing complexity, ranging from the single atom of the rare gas molecule to hundreds of thousands of them. In fact, it is now known that there is no upper limit to the mass and dimensions of molecules: a crystal of diamond, or a piece of vulcanized rubber, can consist of one single enormous molecule.

Yet, although the notion of the molecule remains constant throughout this vast range, as the assemblies of atoms become more complex so they assume progressively new properties. For example, the substances which they make up do not have such well-

* Substance of a lecture given in the University of London on November 7.

defined properties: they cannot exist in the gaseous state; they are not thoroughly crystallizable; and their physical and mechanical properties in the solid state are new, complex and delicately balanced. All the same, new problems arise and new methods of investigation are required for the description of giant molecules. In the case of a molecule containing a very few number of atoms, it is possible to describe exactly the relative mean positions of their nuclei, their vibrations and even sometimes the probability distribution of the electrons which bind the atoms together.

The use of quantum mechanics and of such techniques as spectrometry with radiation ranging from X-rays to microwaves, and even the use of proper chemical methods, generally suffice. As the number of atoms included in the molecule becomes larger, it appears that we have to describe the relative positions of atoms at larger distances, and we have to consider two steps in our investigation. First, using the classical methods just quoted, we try to find out the characteristic atomic groups included in the macromolecule. Secondly, we investigate how these groups are arranged, and we describe their whole assembly with different parameters, according to the type of the macromolecule. If the latter is a quite rigid particle (as a small crystal would be, for example), we use the simple concepts of shape and size. If it is not (as would be the case for a linear and flexible chain of a high-polymer molecule), we use some means of statistical description, as we shall see later on. But the important fact is that for this type of macromolecule it is necessary to add to the ordinary structural data a set of new morphological parameters available to new techniques of investigation.

We could perhaps compare a macromolecule to a large building. The short-range methods enable one to know the kind of stones it is composed of, and even to recognize pieces of walls, windows or staircases, but they cannot give us any idea as to the arrangement of all the parts together. They have to be completed by methods giving the general outline of the building the morphology of which is under investigation. From this point of view, we can give a rough estimate of the limits of the macromolecular domain. It begins when the molecule contains a sufficiently large number of atoms, or atomic groups, to require the use of morphological parameters for its complete description. Despite the fact that each case has to be considered in particular, this number in practice lies around one hundred. At the other end of the scale, particles which can be seen under an optical microscope—that is to say, of a size of about $0{\cdot}2\mu$—are no longer considered as being macromolecules, since, above that limit, the determination of size and shape implies the use of very straightforward macroscopic methods.

We can conclude, therefore, that when a molecule lies in this range of dimensions (10–10,000 A.), or of molecular weights (about a thousand to several million), it is said to be a macromolecule and its complete description requires: the investigation of its chemical composition, which is a problem of chemistry; the investigation of the detailed structure of the clusters or groups of atoms it is composed of, which is a problem of chemistry or of classical physical chemistry; and thirdly, the determination of morphological parameters connected with its size, shape or statistics of configuration, which is the problem of morphology.

Before starting on this last point, which is my principal aim here, let us consider as an example a macromolecule resulting from the polymerization of a monomer such as $CH_2{=}CH{-}X$ (X not being a hydrogen atom). From mere chemical considerations it can be readily determined that the macromolecule is made up of the assembly of divalent atom groups $-CH_2-\underset{\displaystyle X}{\underset{|}{CH}}-$. Next one wants to know how these atom groups are connected together. Of course, they follow one another, but different types of sequence can be contemplated: first, there is the so-called head-to-head or head-to-tail arrangements; secondly, even in the case of a regular head-to-tail sequence (that is, following Natta, the so-called isotactic polymers) it may happen that all the X atoms can be on the same side of the stretched zigzag chain, or distributed at random on one or the other side; thirdly, it may happen that the law of succession is broken during the process of polymerization and that a branching occurs. These three possibilities—which all correspond to the short-range structure domain—can be investigated by pure chemical means (especially the first and third) or by physical means like infra-red or X-ray spectroscopy.

Finally, if one gives numbers from 1 to N to the N carbon atoms of the backbone of the chain, there remains the problem of the position of atom number i relatively to any other, or to the centre of mass of the whole chain. This is the problem of morphology that we shall now examine.

Let us consider the succession of four atoms C_{i-1}, C_i, C_{i+1}, C_{i+2} (Fig. 1) and choose, as a plane of figure, the plane defined by the two vectors $C_{i-1}C_i$ and C_iC_{i+1}. The position of C_{i+2} is not fixed and can be anywhere on the circle Γ_{i+2}, except a possible effect of steric hindrances, which will be taken into account later on. Thus the backbone of the chain can have an infinite number of possible configurations—from the stretched zigzag line to a more or less inextricable coil—and we shall have to determine the statistics of these configurations. They will depend upon the state of the matter which the chains make up: thus they will be different in the liquid state and in the solid state, and in the latter case they will be different if the piece of matter is, for example, stretched or not. In fact, this correlation is responsible for the special physical properties of high-polymer substances. For the sake of clarity, we shall assume that each

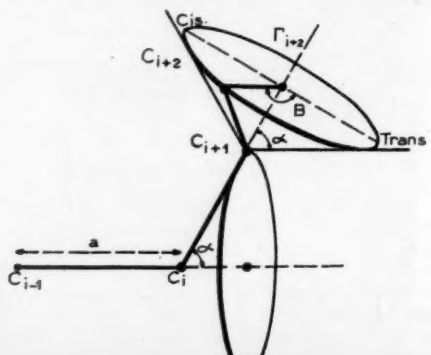

Fig. 1. $a = 1{\cdot}54$ A.; $\alpha = 70° 32'$; $\mu = \cos\alpha = \frac{1}{3}$

chain molecule is individualized, or in other words—since the substance cannot be vaporized—that it is placed in a solvent at an infinite dilution. In that case, we shall have to describe for each macromolecule the configurations of an assembly of N points, linked together as already explained.

Up to now, the general approach has been to give the law of probability of position $W_{i,p}(\mathbf{r})d\mathbf{r}$ of any point C_{i+p} in the element of volume $d\mathbf{r}$, $\mathbf{r}$ being the vector $C_i C_{i+p}$. We may consider also the value of $<r_p^2>$, the average of the square of all the possible distances $C_i C_{i+p}$. The interesting point is that often this value can be calculated directly even when it is not possible to know the expression of the function W_{ip}. Then, we can consider $<\rho_p^2>$, the average value for all the configurations, where ρ_p is the distance of C_p to the centre of mass of the molecule.

The mean value $\rho^2 = \frac{1}{N}\sum_{p=1}^{N} <\rho_p^2>$ of all the $<\rho_p^2>$ for all the points C_p is another interesting quantity, which is called the radius of gyration of the chain.

In principle, all these parameters can be computed as a function of N, a, and $\mu = \cos\alpha$ (Fig. 1), as soon as we know the elementary law of probability of position of each point C_{i+2} on circle Γ_{i+2}. Unfortunately, this calculation is rather difficult, and it can be completely carried out only under the restriction of assumptions the physical meaning of which is sometimes uncertain. The most simple case is when all the atoms of the assembly are supposed to have no volume and no interactions (such as in an ideal gas). In that case, it can be treated as a Markov process. $<r_p^2>$ can be calculated for all values of p (from 1 to N) as soon as the probability of positions of C_{i+2} on Γ_{i+2} is symmetrical on both sides of the *cis–trans* line (Fig. 1). For very large values of p, it can be calculated in all cases, and one obtains the relationship:

$$<r_p^2> = b^2 p, \qquad (1)$$

where

$$b^2 = a^2 \cdot \frac{1+\mu}{1-\mu}\,\frac{(1+c)^2+s^2}{1-c^2-s^2} \qquad (2)$$

c and s being respectively the average values of $\cos B$ and $\sin B$.

When equation (1) can be used, then the function $W(\mathbf{r})$ has a Gaussian form:

$$W(\mathbf{r}_p) = \left(\frac{3}{2\pi b^2 p}\right)^{3/2} \exp\left(\frac{-3r^2}{2pb^2}\right)$$

where b^2 is given by equation (2).

When it is assumed that the excluded volume is no longer negligible and that, due to the energy of dilution, there are repulsions or attractions between the elements of the chain, the situation is much more complicated and no probability theory is available. However, with certain assumptions which seem to be supported by experience, an expression can be given for $<r_p^2>$, for $p = N$ only—that is, for the two ends of the chain. It is found that $<r_N^2>$ is proportional to $N^{1+\varepsilon}$, where ε is an increasing function of the second virial coefficient B of the solution. $\varepsilon = 0$ when $B = 0$ (ideal solution).

Finally, in the case of large values of N and for real as well as for ideal solutions, the radius of gyration is given by the equation:

$$\rho^2 = <r_N^2>/(2+\varepsilon)(3+\varepsilon)$$

No matter what the basis of these theoretical or semi-theoretical results may be, the important fact is that the morphological parameters $W(\mathbf{r}_p)$, $<r_p^2>$, ρ_p^2 and ρ^2, which replace the very simple notions of size or shape available for rigid molecules, can be more or less derived from proper measurements performed on solutions.

The general principle upon which these methods are based is to measure the value Φ of a physical character of the solution or its excess compared with the same character of the solvent (that is, viscosity, turbidity, etc. . . .). Generally, Φ is proportional to the number ν of the solute molecules per cubic centimetre, and we may write:

$$\Phi = \nu\varphi = N_0 \frac{c}{M}$$

where N_0 is the Avogadro number, M the molecular weight of the solute, and φ the physical contribution of each single molecule. In general, the magnitude of φ depends on the other molecules in the neighbourhood, so that we may write:

$$\varphi = \frac{N_0}{M}\varphi_0 + c\varphi'_1 + \ldots\ldots$$

where φ_0 is the contribution of a molecule of the solute when it is alone in the whole solution. We have then:

$$\Phi/c = \frac{N_0}{M}(\varphi_0 + \varphi'_1 + \ldots\ldots\ldots)$$

and we can see that the value of φ_0 will be obtained in extrapolating to $c = 0$ the values of Φ/c measured at different concentrations. This is very important, because until now the theories linking φ to the macromolecular data can be set up at their maximum degree of accuracy, when the interactions between solute molecules are negligible. Generally, the interpretation of coefficients φ_1' and so on is more or less unsound—hence the necessity of the extrapolation process just quoted.

We can perhaps try a classification of the main methods into three groups.

(1) Methods which give independently M, or M plus morphological parameters: measurement of the osmotic pressure gives M and also B, the latter being more or less connected with the morphology of the macromolecule; measurement of light scattering also gives M and B, and, moreover, the radius of gyration ρ can be obtained so long as it is larger than a twentieth part—or about—of the wave-length of the incident light.

(2) Methods giving only morphological parameters: measurement of the Brownian translatory diffusion constant.

(3) Methods giving a result dependent simultaneously on the molecular weight and morphology: measurement on intrinsic viscosity; measurement of sedimentation velocity; and measurement of double refraction of flow.

The mass is obtained from osmotic pressure or light-scattering measurements using the general laws of thermodynamics, and this procedure is not open to criticism. The same reliability can be vouchsafed for the theory whereby ρ is derived from light scattering, and it is still fairly sound to derive the value of M from a combination of sedimentation velocity and Brownian diffusion. But all the 'hydrodynamical' methods such as measurement of viscosity, or sedimentation velocity (when used for

morphology), have until now had no completely solid theoretical basis. However, they can be used as semi-empirical methods, and viscosity, from this point of view, is quite useful because of its very simple experimental device. In the present state of affairs, there can be little doubt that the light-scattering method is the most reliable, both from the theoretical and experimental points of view. Its generalization to the use of small wave-lengths (for example, X-rays) makes it useful even to the lower limit of the macromolecular domain.

Though it may be felt that the work leading to a complete description of a chain macromolecule—including its morphology—does not need any further justification, it is nevertheless useful to indicate a few aspects of its consequences. Nobody, in fact, doubts the necessity of inquiring about the molecular weight and the short-range structure of a chain, since these factors are of first-rate importance with regard to the properties of matter in bulk—as in rubber or plastic materials—or to the biological specificity of the macromolecule itself in the living organisms, as is the case for proteins or nucleic acids. But it may be reasonable to ask whether it is of any interest to spend so much time and effort in order to describe more accurately the complicated wriggling of a worm-like molecule in its solution.

This question may be answered in a number of ways. First, methods which are widely used for determining molecular weights give—as is the case in the scattering of light—morphological parameters, and the very straightforward curiosity inherent in a scientist's mind would have to be arbitrarily restrained if he were not to try to understand their meaning. Secondly, and more important, the morphological results may lead to significant improvement in the knowledge of the structure itself. Since ρ, for example, depends on steric hindrances, its value depends in principle on the sequence of the atomic groups in a chain. Though it could be slightly changed when head-to-head arrangements are changed to head-to-tail, the effect is much larger when branching occurs. In fact, the determination of morphological parameters is a quite useful way of investigating branching in high polymers.

The third reason appears to me to be the most important one. I have implicitly assumed, in the foregoing discussion, that all the molecules in a solution were identical. Actually, this is not so. A sample of high polymer coming from an autoclave, as well as a sample of nucleic acid extracted from a chromosome, contains a mixture of different molecules. It is then of the utmost importance—for the improvement of our fundamental knowledge in chemistry as well as in biology—to analyse this heterogeneous or poly-disperse medium. The different species have to be characterized and, if needed, separated. This is very often done by using their difference in solubility; but it can also be achieved by using their difference in morphological parameters (after all, this is the principle of Svedberg's experiments on proteins), and this method is sometimes more direct and can lead to much clearer results. There is little doubt that it will be one of the most efficient means of resolving this problem, which is one of the most irritating in the present state of our knowledge.

As a conclusion, the morphology of large molecules, which is a new and well-defined chapter of physical chemistry, is essential for increasing our knowledge on macromolecules. Of course, this part of science has not the relish of, for example, nuclear physical chemistry. If the first half of this century be thought of as the era of the dawn of nuclear bombs and reactors, perhaps the argument could be advanced, without daring too much, that during the second half the synthesis of materials replacing the traditional natural products and our increased knowledge of fundamental biological processes may in their turn, though in a less spectacular way, weigh very heavily on our future. In this field the morphology of large molecules plays a modest but unquestionable part; it would be an error to misunderstand it.

CHEMISTRY AND CROP NUTRITION

THE problem of providing adequate food for an increasing world population, and the disastrous and far-reaching consequences of inadequate nutrition, are perhaps more widely realized now than ever before. But it is improbable that it is clearly and universally realized that the ultimate source of our food is the soil and that, were it not for the application of science to agriculture, famine would have overtaken us in Great Britain as a result of an increase in population from ten and a half to forty-nine million during the past hundred and fifty years. This was clearly brought out by Sir William Ogg, director of the Rothamsted Experimental Station, in the ninth Dalton Memorial Lecture, given in Manchester on October 28 under the auspices of the Royal Institute of Chemistry. In the Lecture, which was entitled "Chemistry and Crop Nutrition" and has since been published*, Sir William discussed the contribution of science in general, and of chemistry in particular, to the maintenance of soil fertility.

Early manurial practice, with little or no understanding of its theory, relied in the main upon animal manures, and it was not until early in the nineteenth century that scientific ideas about manuring began to develop as the result of the work of de Saussure, Boussingault, Liebig and others on the Continent of Europe and of Lawes and Gilbert in Britain. The discovery by Lawes in 1842 that treatment of mineral phosphate with sulphuric acid resulted in the production of the phosphatic fertilizer superphosphate, and the setting up of a factory by him for its manufacture, were the beginnings of the modern fertilizer industry.

Lawes and Gilbert during fifty-seven years of active collaboration at Rothamsted carried out investigations into the principles of crop nutrition, the results of which laid the foundations of our present knowledge of manuring. They succeeded in showing the long-term effects of nitrogen, phosphate

* Royal Institute of Chemistry. No. 5: Lectures, Reports and Monographs Series of the Royal Institute of Chemistry. Pp. 13. (London: Royal Institute of Chemistry, 1955.) 3s.

and potash, both singly and in combination, and some of their field experiments, the classical plots, have been continued at Rothamsted to the present day. Their pioneer work was followed by the use of increasing quantities of nitrogenous, phosphatic and potassic fertilizers in addition to the traditional organic manures. Supplies of phosphatic fertilizers presented no problem since there were known deposits of naturally occurring rock phosphate, and in 1861 the commencement of the working of potash salt deposits ensured a supply of potassic fertilizers. Not until forty to fifty years ago, however, when fixation of atmospheric nitrogen on an industrial scale became possible, could adequate supplies of nitrogenous fertilizers be assured.

Sir William directed attention to the recent rapid rise in fertilizer consumption in Britain, the need for fertilizers being accentuated by intensification of cropping and reduction in imports of animal feeding stuffs. A wide range of fertilizers is now provided by modern chemical industry. In addition to ammonium sulphate, superphosphate and basic slag, such nitrogenous and phosphatic fertilizers as liquid ammonia, ammonium nitrate, calcium nitrate, urea, nitrophosphate, triple superphosphate and silicophosphate are available. Supplies of potassic fertilizers are still directly dependent upon deposits of potash salts in various parts of the world. Other major plant nutrients, apart from nitrogen, phosphorus and potassium, include calcium, magnesium and sulphur, and the significance of these was referred to by Sir William; there are also the trace elements (iron, manganese, copper, zinc, boron, molybdenum and chlorine) which, when deficient in the soil, and in some cases when present in excess, are responsible for reduction in crop yield or for disease in both crops and stock.

The precise determination of the manurial requirements of crops is a matter of no little difficulty. Different soils of varying fertility vary in their response to fertilizer application, and that section of the lecture which Sir William devoted to soil testing makes it quite clear that soil fertility cannot be completely explained in chemical terms, since biological, physical and climatic factors are involved also. Total chemical analysis of soil reveals only the quantities of potentially available plant nutrients.

Arbitrary chemical methods for determining the amounts of phosphorus and potassium in the soil that are available to the plant, and the amount of lime necessary to correct soil acidity (the lime requirement), have been developed, and the results, correlated with those of field experiments, can be interpreted in terms of fertilizer application to crops. Nitrogenous manuring, however, still lacks a reliable method of soil analysis upon the results of which guidance can be given, and although field experimentation has provided many useful data, more precision is desirable.

The phenomenon of base exchange in soils and the nature of the clay and humus of soils are of first importance in crop nutrition. Sir William dealt briefly with the researches which have increased our knowledge in this connexion and directed attention to the practical application of the results of these researches. Sound manurial practice involves the maintenance of a suitable balance between the amounts of the various exchangeable cations, and a further application of the principle of base exchange is the use of gypsum in the reclamation of saline and alkali soils in various parts of the world, and of soils flooded by sea water. By the release of exchangeable sodium ions from the soil colloids and their replacement with calcium ions, the deflocculation of the soil colloids is prevented and a favourable soil structure for plant growth ensured. New techniques applied to the study of clay and humus have revealed properties intimately concerned with the physical conditions of soils and with their capacity to take up and retain plant nutrients.

Lastly, Sir William discussed the relationship between organic manures and fertilizers, pointing out that in Britain half the food for crops still comes from farmyard manure, which also improves soil texture and enhances the capacity of the soil to retain water and plant nutrients. Fertilizers, however, are essential since farmyard manure may be deficient in necessary plant nutrients, and moreover, the amounts of organic manures available are not sufficient to meet the needs of present-day intensive farming. The contentions of those who are opposed to the use of fertilizers and who condemn all chemical aids to agriculture on the grounds that there is some vital principle present in organic manures which must be transmitted to the soil if crops, livestock and the human population are to remain healthy, are without scientific foundation. The alleged harmful effects of fertilizers existed before they were discovered and are rife where they have never been used.

This Dalton Lecture was a reminder that, besides his world-famed work in chemistry and atomic theory, John Dalton made notable scientific contributions to meteorology; all agricultural scientists concerned with the water requirements of crops owe to him the first clear ideas of the nature of the evaporation processes, and Dalton may be said to have laid the foundation for modern work in this field.

J. S. Willcox

OBITUARIES

Prof. W. M. H. Greaves, F.R.S.

W. M. H. Greaves, Astronomer Royal for Scotland and professor of astronomy in the University of Edinburgh, who died suddenly on Christmas Eve at the age of fifty-eight, was one of that distinguished series of Cambridge men who have held the Isaac Newton Studentship. His published papers cover a wide range of astronomical subjects, from perturbation-theory to geomagnetism; but his principal interest was the use of photography for the study of the spectra, and especially the continuous spectra, of stars. His appointment as chief assistant at Greenwich, in 1924, gave him his initial opportunity in this field, and he seized and developed it with characteristic enthusiasm. The 30-in. reflector, mounted on the same assembly as the 26-in. refractor (to the great inconvenience of both), was all that was available for such work at the Royal Observatory of that day, but Greaves took such obstacles in his stride. The rather less obvious (but much more formidable) challenge presented by the Greenwich sky was met by rigorous adherence to well-considered rules for observing, and the small probable errors of the results which were obtained testify to the judgment, as well as the courage, which lay behind the whole programme. Six years after his arrival at Greenwich,

"gradients" were published for twenty-four stars "suitable for use as spectrophotometric standards", and these intercomparisons were of such quality that they scarcely had to be modified at all as a result of the main programme which followed. This comprised 250 stars, most of them fainter than the standard ones; but the foundations had now been laid, and the advent of the new 36-in. Yapp reflector in 1934 also speeded the work. By 1938, when Greaves was appointed to Edinburgh, there was little still to do except publish the extensive results.

An essential part of photographic spectrophotometry is the calibration of the plates, and since it would have been very time-consuming to use, in this, the long exposures which had to be used on stars, the question of 'reciprocity failure' had had to be faced. Greaves reduced this somewhat venerable bogey to very manageable proportions, and definitely established the value of photography as a precise quantitative tool, at a time when photocells were still too insensitive to compete in this field.

The Second World War came soon after his move to Edinburgh, and for a while his principal concern was with the time service, where he co-operated closely with the Greenwich station that had been evacuated to Abinger; a substantial share of the advance in accuracy which occurred about this time, in spite of difficult conditions, was due to him. After the War, he obtained for his Observatory a badly needed increase in staff, and spectrophotometric data both on the Sun and on early-type stars have come increasingly from Edinburgh in recent years. Extensive work is in progress that would undoubtedly have benefited further from his leadership if he had lived.

Greaves definitely enjoyed taking charge of things, and could keep a committee firmly to the point. He served for six years as secretary of the Royal Astronomical Society, and was president during 1947–49. He was an active member of several commissions of the International Astronomical Union, serving for seven years as president of the one for photometry. His influence in the British National Committee for Astronomy was considerable, and he was one of the keenest sponsors of the plan for a large paraboloid at Jodrell Bank.

He will be warmly remembered by those who have worked under him, and with him. His complete integrity, and his devotion to astronomy, were unquestionable; but his numerous generosities may often have been less commonly known. The proportion of his papers which bear also the names of one or more subordinates is high, and this reflects not only his scrupulous fairness but also his power of stimulating the best efforts of his staff in the first place. He was capable of brusqueness, and even more, on occasion; but those who could see past this will remember the very real tact and skill with which he would guide and help all, whether old subordinates or new colleagues, who were associated with him.

R. d'E. Atkinson

Dr. F. H. Burstall

Dr. F. H. Burstall, who died on December 2 at the untimely age of fifty-two, had spent the whole of his working life at Teddington. He was one of a small band who were recruited by the late Sir Gilbert Morgan to staff the Chemical Research Laboratory (of the Department of Scientific and Industrial Research) when it was founded in 1925; and it can be said with truth that no one has done more to establish the prestige and repute that the Laboratory has, in the meantime, achieved.

The second son of the late Prof. F. W. Burstall (who held the chair of mechanical engineering and was dean of the Faculty of Science in the University of Birmingham), Francis Burstall did not follow the profession in which other members of his family have achieved distinction. After graduating at Birmingham with first-class honours in chemistry, he became research assistant to Morgan, who had been his professor and was about to take up a new appointment as superintendent of the Teddington Laboratory.

As a young man Burstall was entirely unsparing of the time and effort he applied to chemical research. He made substantial contributions to the organic chemistry of selenium and tellurium, undeterred by the frequently obnoxious nature of the materials he had to handle. It was, however, by his work on metallic co-ordination compounds that he won recognition as an authority in a field then little cultivated. In a book published in 1933, of which he was co-author with Morgan, he provided an admirable survey of the more recent developments in this branch of inorganic chemistry.

When war came in 1939, Burstall was obliged to take on a succession of problems which, important though they were at the time, offered little of continuing interest, and it was only with the ending of hostilities that his Department was able to make the best use of his very versatile ability. In 1947 he was placed in charge of a small section set up to study the analysis of uranium and thorium ores on behalf of the Department of Atomic Energy. The extraordinary value of the contribution that he and the staff he led (and inspired with some of his own enthusiasm) were able to make to the national effort in this new field was quickly recognized. Greater responsibilities were laid upon Burstall, and his unit ultimately became so large that an extensive new building was constructed and equipped to accommodate what now became the Radiochemical Group of the Chemical Research Laboratory. Those who knew what Burstall put into his task will always see in this fine laboratory a memorial to his success in what, unfortunately, was to be the last phase of his scientific career. Much must remain untold; nevertheless, the series of papers in which he and his colleagues revealed their application of chromatography to the separation of metals indicate the power and generality of a technique they were among the first to use. The formal seal was set on Burstall's accomplishments in chemical research when in 1952 he attained the academic distinction of D.Sc. of the University of London.

Modest and self-effacing, Burstall was nevertheless a man whose judgments were shrewd, being based on wide (if unparaded) knowledge and deep self-communion. He had an extraordinary charm for his friends and colleagues. This was due to the utter impossibility for him to do or say anything in the slightest degree unkind or inconsiderate. His main preoccupation throughout his life was with chemistry, which to him was far more than the means to a livelihood. To purely personal advancement he never gave a thought; nevertheless, he found a high degree of self-fulfilment as a scientist in the service to which he gave his loyalty and whose traditions he upheld.

In the course of his last illness he underwent two major operations and it almost seemed after the first that hope could be entertained of a recovery. Un-

fortunately this was not to be. Dr. Burstall bore his grievous afflictions with stoicism for more than twelve months. He is survived by his wife, whom he married in 1929, and two sons. E. A. COULSON

Prof. G. T. R. Hill

PROF. G. T. R. HILL, who died recently at his home in Ireland, was a member of a very distinguished family. His father, the late Dr. M. J. M. Hill, was professor of mathematics and a vice-chancellor of the University of London. His elder brother, the late Air Chief Marshal Sir Roderic Hill, became rector of the Imperial College of Science and Technology and also vice-chancellor of the University of London, and his sister, Dr. Gwen Hilton, is now director of the Radiotherapy Department of University College Hospital.

The two brothers both had close interests in aeronautical engineering, and though their careers were quite different, one was very much complementary to the other in its contribution in this sphere to progress during the past thirty years.

Even as a boy, Geoffrey Hill's future career was unmistakably marked out. He spent much of his spare time making aircraft models, and at the age of seventeen secured a place for one of them at the Children's Exhibition at Olympia. He was educated at University College School and afterwards at University College, London, where as an engineering student he graduated in 1914. After a period of active service in the Royal Flying Corps at the beginning of the First World War, when he rose to the rank of captain and was awarded the Military Cross, he undertook responsibilities in aeronautical research for the Air Ministry. After demobilization in 1919 he pursued his absorbing interest in aeronautics as an experimental engineer and chief test pilot to Messrs. Handley Page, Ltd. By this time he had acquired a background of knowledge and experience which, coupled with his inventive ability, enabled him, in collaboration with his brother, to conceive the idea of the tail-less aircraft or Pterodactyl as it was afterwards called.

In 1922 Hill was awarded an 1851 Exhibition Senior Studentship, and after two years of research to test the validity of the principles that the two brothers had enunciated, he began the design and construction of a Pterodactyl. The work was supported in its early stages by the Aeronautical Research Committee and eventually the machine was further developed in association with the Westland Aircraft Co. when he joined that firm in 1926. It was shown to the public for the first time at the R.A.F. pageant at Hendon and is now in the Science Museum at South Kensington, where it bears witness to the great contribution which the two brothers made to aeronautical science by establishing the important principles demonstrated in this machine. The industry to-day owes them a deep debt of gratitude.

In 1934 Geoffrey Hill returned to his old College as Kennedy professor of engineering, and he held that post with great distinction until 1947, when he resigned to re-enter the aircraft industry as consultant to Short Brothers and Harland, Ltd., of Belfast. During the Second World War he was seconded to the Air Ministry and later the Ministry of Aircraft Production for research work, and as a pioneer in the invention of the isoclinic wing he made valuable contributions in helping to maintain the superiority of the Allies in the air. He was elected to fellowship of the Royal Aeronautical Society, and was awarded the D.Sc. in engineering of the University of London.

His most delightful personality and his charm of manner will always be treasured by the wide circle of his friends and acquaintances. His death at the early age of sixty is a great loss, not only as a personal one, but also to the science of aeronautical engineering.

H. M. BARLOW

NEWS and VIEWS

Wellcome Museum of Medical Science : Lieut.-Colonel C. A. Bozman, O.B.E.

LIEUT.-COLONEL C. A. BOZMAN has been appointed director of the Wellcome Museum of Medical Science, and will take up his duties on February 1. Colonel Bozman, who received his medical training at the University of Edinburgh, joined the Indian Medical Service in 1924. He held various public health and laboratory appointments, including that of director of public health, Burma, and became a public health commissioner to the Government of India. After his retirement in 1947 he was successively lecturer in public health in the University of St. Andrews, health counsellor at the British Middle East Office, Cairo, and professor of preventive medicine at the University College of East Africa (Makerere College). His new post with the Wellcome Foundation will enable Colonel Bozman to apply his wide knowledge of tropical medicine and pathology in the service of a Museum which has specialized in this field.

Glasshouse Crops Research Institute : Dr. W. F. Bewley, C.B.E.

DR. WILLIAM F. BEWLEY retires from the post of director of the Glasshouse Crops Research Institute next summer. Bewley was educated at the University of Durham and first joined the staff of Rothamsted Experimental Station, being seconded for service in the Royal Field Artillery during the First World War. While at Rothamsted he collaborated with the late Dr. H. B. Hutchinson on the classic researches on partial sterilization of soil which were later to prove the salvation of the tomato industry. In 1919 he went to the research station in the Lea Valley founded in 1914 by the glasshouse growers of the district and later to become world-famous under his leadership as the Cheshunt Experimental and Research Station. He became director in 1921, and instituted the long series of experiments on glasshouse crops which laid the foundations of modern techniques. His many years of experience, first as a mycologist and later as an authority on all aspects of glasshouse cultivation, were summed up in his two standard books, "The Diseases of Glasshouse Crops" and "Commercial Glasshouse Crops". In 1954, the old Cheshunt Station became the new Glasshouse Crops Research Institute, with Bewley as director, and in 1955 its staff moved to the new site at Toddington near Littlehampton. Bewley's warm, friendly nature, together with his exceptional powers

of lucid exposition, have long endeared him to the industry, and to-day there is no man who stands higher in the respect and affection of the glasshouse growers of Great Britain. Not least among his admirers are the growers of the Channel Islands, to whom he pays regular visits.

Mr. F. W. Toovey, O.B.E.

Mr. F. W. Toovey, who has been appointed to succeed Dr. Bewley, graduated from the Imperial College of Science and Technology, London, where he was awarded the Forbes Medal and Prize. He was then selected for the Colonial Agricultural Service, and after postgraduate work at Cambridge and in Trinidad, was appointed to the Nigerian Agricultural Department in 1935. In Nigeria his work was concerned almost exclusively with the oil palm, a crop of the greatest importance in the economy of the country. Twenty years ago, very little study had been devoted to the crop, but a lead had been given by the fine work that was being done by the Belgians at the I.N.E.A.C. In 1938 Mr. Toovey was sent to the Belgian Congo to report on the progress made in oil palm research there, and returned to take part in the development of the Oil Palm Research Station of the Agricultural Department of Nigeria. Largely under his direction, this station, which covered, initially, 4,000 acres of undeveloped tropical forest, was built up as the main centre for oil palm research in Nigeria, with many supporting out-stations. In 1952 the station assumed responsibility for research in all the British West African territories, becoming an autonomous institute known as the West African Institute for Oil Palm Research (W.A.I.F.O.R.). Mr. Toovey was appointed its first director, and for his services was made O.B.E. in the New Year's Honours list of 1955.

Chair of Marine Engineering at Newcastle upon Tyne

The Council of King's College, Newcastle upon Tyne (University of Durham), has announced the receipt of £35,500 from local industrial firms towards the endowment of a new chair of marine engineering at the College. This sum is additional to some £22,000 which was contributed to the College two years ago and earmarked for the development of marine engineering studies. The two sums together provide sufficient funds to proceed immediately to the appointment of the first professor. A separate undergraduate course in marine engineering has been provided at the College—then Armstrong College—since 1913, in the Department of Mechanical and Marine Engineering, of which the present head is Dr. Aubrey Burstall, professor of mechanical engineering. In August 1954 he suggested to the Council that the Department had grown so large that a second professor should be appointed to work in his Department and that he should be designated professor of marine engineering. This proposal was accepted and afterwards widely approved by industrialists and others concerned in marine engineering in Britain. It is hoped to attract more university men into the marine engineering industry and to develop a centre for marine engineering studies at King's College, where there already exists one of the largest university departments of naval architecture (under Prof. L. C. Burrill) in Britain.

Protection against Ionizing Radiations

The International Labour Office made history in the field of protection against ionizing radiation when, in 1949, it introduced its Model Code of Safety Regulations. The relevant sections of the code are included in a report submitted to the International Conference on the Peaceful Uses of Atomic Energy, Geneva, 1955 (The Protection of Workers against Ionising Radiations (International Labour Office, Geneva, 1955). 50 cents ; 3*s*.). In 1955 it seems, as the report states, "out of date in some respects . . . and is now due for revision". Nevertheless, this code of practice has been in print and outdated, while no British National Code has yet appeared since the demise of the British X-ray and Radium Commission. A report, therefore, by the International Labour Office, progressive as it is in this field, is worthy of study. It recommends the adoption of the general principles of protection laid down periodically by the International Commission on Radiation Protection. If it accepts its own recommendation, it will have to revise its Model Code drastically in a number of important respects—including incidentally Regulation 208.7, which states that photographic dark rooms should have some natural lighting. It reviews the effect of ionizing radiations on human beings (in parts this is a little naïve, indicating that the author was not a medical man) ; the uses of ionizing radiations ; protective measures ; problems arising in uranium mining and processing ; and safety in transport of radioactive materials. It is at its best when it deals with the problems met with to-day in industry. It therefore behoves the industrialist about to use the newly available tools of radioactivity and ionizing radiation to study it. The industrial medical officer and the Ministry of Labour will note, no doubt, the recommendation of the International Labour Office that diseases due to ionizing radiations be included in the international list of occupational diseases to be notified to the labour inspectorate.

Veterinary Research in Britain

In the committee stage of the Agricultural Research Bill, which received its third reading in the House of Commons on January 26, Mr. A. J. Champion, Captain J. A. L. Duncan and Mr. Leslie Hale pressed for more attention to veterinary research and to livestock farming as contrasted with crop husbandry. For the Government, the Joint Parliamentary Secretary to the Ministry of Agriculture, Fisheries and Food, Mr. C. R. H. Nugent, while maintaining the view previously expressed that a separate veterinary research council is undesirable and that veterinary research as well as general agricultural research appropriately come under the Agricultural Research Council, promised to take note of the comments made and particularly of the importance of developing preventive veterinary work in agriculture to-day. He pointed out that the Lord President's Committee would consist of the Minister of Agriculture, Fisheries and Food and the Secretary of State for Scotland.

The Houghton Poultry Research Station

The Animal Health Trust founded its Poultry Research Station at Houghton, Huntingdonshire, some seven years ago, and under the leadership of Dr. R. F. Gordon the staff has done much useful work on behalf of the poultry industry. The Trust and the Agricultural Research Council have now

agreed on financial co-operation on lines which should satisfy the aims of both the Trust and the Council for the expansion of research facilities and meet the conditions essential to the provision of government financial support. Under these arrangements the Trust will contribute one-third of the net annual maintenance expenditure up to £10,000 a year and the Agricultural Research Council will contribute the other two-thirds, with freedom to each party to give more if they wish and if it is in the interests of the Station. The Station is to have an independent status and will be known as Houghton Poultry Research Station. It will be governed by a board of nine members who have been appointed by the Lord President of the Council, the Minister of Agriculture, Fisheries and Food and the Secretary of State for Scotland, three of them having been nominated by the Animal Health Trust. They are as follow: Mr. T. H. Turney (chairman), Prof. E. C. Amoroso, Mr. H. Finn, Mr. G. Guttridge, Mr. F. Grove, Prof. K. Mather, Lord Stamp, Prof. E. G. White and Dr. W. R. Wooldridge.

New Zealand Heavy-Water Scheme

THE United Kingdom Atomic Energy Authority, after consultation with the New Zealand Government, has decided to withdraw from participation in the Wairakei Scheme. This scheme provided for utilizing geothermal steam for the generation of electric power and for the manufacture of heavy water, the New Zealand Government being interested in the former product and the Atomic Energy Authority in the latter. It has now been found that the cost of constructing the heavy-water plant would be much higher than was originally estimated. A company, Geothermal Development, Ltd., was formed for this purpose, and this will be wound up in due course. The New Zealand Government is to continue with the power station project.

Combustion Institute

THE great interest in research in the field of combustion in the post-war period has been made evident by the support accorded the three symposia held in 1948, 1952 and 1954. To undertake the responsibility of organizing such symposia, a sub-committee was formed in the United States, with representatives from industry, government and universities, and this sub-committee, in conjunction with the honorary members of the Standing Committee in Belgium, France, Great Britain and Netherlands, recommended that a "Combustion Institute" should be founded. The Institute was incorporated in the State of Delaware on July 1, 1954, and at the first meeting of its members, held in Pittsburgh on September 1, 1954, during the fifth symposium, a board of directors of fifteen members was elected, and two working committees were established—the Executive Committee and the Combustion Institute Committee. The latter comprises representatives from a number of different countries, and it is intended that the symposia should continue to be international in character. It is in no way the intention of the Combustion Institute to compete with other societies either in its meetings or publications, but its main object is to encourage activity in this important field crossing the boundaries of so many scientific and engineering disciplines. The first symposium under the auspices of the newly formed Institute will be held at Yale University during August 19–24. The British members of the Combustion Institute Committee (Sir Alfred Egerton, Dr. J. S. Clarke and Mr. P. Lloyd), with Dr. J. W. Linnett, form the British Committee. Further information can be obtained from the assistant secretary, Miss H. Smith, c/o Joseph Lucas, Ltd., Great King Street, Birmingham 19.

Geochemical Society

AT a meeting of the Geological Society of America, held in New Orleans on November 7, the organization of a new society, the Geochemical Society, was completed, and a constitution was adopted which specifies that "The object of the Society shall be to encourage the application of chemistry to the solution of geological and cosmological problems" and that "any person who is qualified to advance the objects of the Society shall be eligible for membership". Thus membership is open to physicists, biologists, mathematicians, oceanographers, meteorologists, etc., as well as chemists and geologists. Those wishing to become charter members should send their names, addresses, fields of interest, and a year's subscription (2 dollars) to the treasurer, Dr. George T. Faust, U.S. Geological Survey, Washington 25, D.C. Names of those who might be interested, but who are not on the "List of Persons doing Research of Interest to Geochemists" (*Geochimica et Cosmochimica Acta*, **6**, 132; 1954) would also be appreciated. The following have been elected officers of the Society: *President*, Earl Ingerson (U.S. Geological Survey, Washington); *Vice-President*, Julian R. Goldsmith (University of Chicago); *Secretary*, John C. Maxwell (Princeton University); *Treasurer*, George T. Faust; *Councillors-at-Large*, J. W. Greig, W. F. Libby, W. T. Pecora, W. W. Rubey, G. R. Tilton and H. S. Yoder.

The Hakluyt Society

THE Hakluyt Society exists to publish original narratives of important voyages and travels and other geographical records. The volumes, two of which are generally issued for each year, are made up of the original documents together with introductory material of great value to the geographer, historian, ethnologist and, not infrequently, to other students of the natural sciences. Since its beginning in 1846, the Society has issued one hundred volumes in its first series and one hundred and seven in its second (current) series. Throughout the greater part of its history, its annual subscription remained unchanged at one guinea, and only in 1955 was it increased to two guineas, a modest sum to pay for two volumes of its publications. At irregular intervals the Society produces an 'extra' series. The great collections of Richard Hakluyt and Samuel Purchas have already appeared in this series, these being little more than reprints of the original works. Perhaps the most ambitious and the most important work in this series is the definitive publication of the "Journals" of Captain James Cook, edited by Dr. J. C. Beaglehole. Here the Society is not merely following its normal practice in printing journals and other documents that have not previously been published from the original manuscripts, but is adding a volume dealing particularly with the scientific results of these great voyages. Vol. 1, covering the first voyage, and a portfolio of original charts and views drawn on all three voyages, have recently been published; the whole project will be completed in four volumes. Last year Mr. J. N. L. Baker succeeded Mr. Malcolm Letts as president

Mr. Letts has occupied the office for five years and has made valuable contributions to the publications of the Society. The honorary secretary of the Society is Mr. R. A. Skelton, superintendent of the Map Room of the British Museum (London, W.C.1), who has done much in helping with the publication of the Cook volumes.

Physics and Philosophy

The first Robert Grosseteste Memorial Lecture, given by Lord Cherwell on May 21 last, was delivered most appropriately in the Chapter House of Lincoln Cathedral; it has now been published (pp. 21. London: Oxford University Press, 1955; 2*s*. 6*d*. net). In it Lord Cherwell performs a valuable service in pleading for a closer understanding between physics and philosophy such as, in broad outline, existed in the lifetime of the great bishop and scholar in whose honour he was speaking. An exceptionally clear picture is presented of the æsthetic choice before the investigator in modern physics, coupled with the recognition that an axiological element is not excluded, thus revealing a measure of personal preference. It is one of the major tragedies of modern thought that the natural philosopher of to-day is expected to know all the answers, whereas, in fact, he is taking a quite limited sector of awareness as his plane of discourse—and likewise for workers in other fields of knowledge. The well-known antipathy of metaphysicians towards mathematics, and the reluctance of physicists to meditate upon fundamentals, are symptoms of a somewhat arid intellectual climate in which the triumphs of science have been won, but which is not necessarily conducive to "helping bewildered humanity to confront the mysteries of existence".

Green Earthworms

The eastern United States has been invaded by a plague of green earthworms (Smithsonian Institution News Release, Dec. 9, 1955). In a few areas these immigrants from China and Manchuria have become a serious problem for keepers of golf courses because of their borings in putting greens. In a night they may cover a best-kept green with little piles of earth. This particular earthworm, *Pheretima hupeiensis*, was first described more than fifty years ago from the Hupei Province of China, and its first appearance in the United States, near Philadelphia, was noted in 1933. Since then there have been numerous reports from golf clubs which almost unquestionably deal with the same species. Presumably it was introduced into America on some kind of nursery stock from China and has been spread by transportation of turfs from one golf course to another. It is such a serious problem in Westchester County, N.Y., and southern Connecticut that the Connecticut Agricultural Experiment Station has instituted a control programme. It is a slender worm, 1–3 in. long. Its colour varies from pale green to deep olive. A distinct purple or black line is apparent on the back.

The Cross-Bill

One of the excellent leaflets issued by the Forestry Commission deals with the cross-bill, *Loxia curvirostra* (Leaflet No. 36; pp. 11. London: H.M.S.O., 1955; 9*d*. net). Besides an illustrated description of the bird, accounts are given of its habitat, song, behaviour, feeding habits and distribution in Great Britain. For the forester the important section is one describing its economic significance. Although the cross-bill does not breed anywhere in Great Britain in numbers large enough to cause the slightest alarm to foresters, it cannot be described as a 'beneficial' bird; it takes some insects and some of them may be harmful to sylviculture, though the amount involved is too small to be of economic account. The leaflet recommends that, for the present, it is best to regard the cross-bill as a highly specialized inhabitant of mature coniferous woodland the ordinary life-history and feeding habits of which are by no means well known, and which—in respect of the periodic invasions—poses a problem of great biological interest still awaiting solution.

Gold Coast Pteridophyta

A comprehensive list of the Pteridophyta in the Gold Coast has recently been prepared by C. D. Adams and A. H. G. Alston (*Bull. Brit. Mus.* (*Nat. Hist.*) *Bot.*, 1, 6, 143; 1955). This is an up-to-date statement of the taxonomy, nomenclature and broad distribution of most of the indigenous species, and includes habitat notes based on extensive field observations in the Gold Coast and neighbouring territories and on collectors' annotations. The classification used for the ferns is that of R. E. Holttum (1947). The Pteridophyta are poorly represented in the savannah country and include only such plants as show a geophytic habit or are aquatic annuals. Endemic species are stated as being almost totally absent. Pteridophytes other than the ferns are represented by a relatively small number of species.

Films in Human Relations

The industrial committee of the Scientific Film Association organized a conference at Ashorne Hill during May 24–26, 1955, on the use of the film in the improvement of human relations in industry, and the report of the proceedings (pp. 24; from the Association; 2*s*. 6*d*.) shows the need for more readily accessible information about available films that are suitable for education and training in industry. A new and comprehensive catalogue of all industrial films available in Great Britain is both desirable and necessary. Such a publication would not be an end in itself. To be of lasting use it would have to be supplemented by an information service which could keep catalogued information up to date and answer specific inquiries about industrial films. The Scientific Film Association is anxious to provide such a service, which can, however, only be established when sufficient funds are available. To gather information in this way is an important step which must be taken before further serious investigation can be made into the use and efficacy of films in industry.

Indian Society of Genetics and Plant Breeding

The sixteenth annual general meeting of the Indian Society of Genetics and Plant Breeding was held at New Delhi on December 12 under the presidentship of Dr. T. R. Mehta, joint director of research, Madhya Bharat College of Agriculture and Research Institute, Gwalior, who delivered an address on "The Genotype in Agriculture". At the meeting it was decided to organize a symposium, to be held later in the year, on the role of genetics in the improvement of tropical crop plants. The following were elected officers of the Society for 1956: *President*, Prof. V. M. Chavan (Poona); *Vice-Presidents*, Dr. P. N. Bhaduri (New Delhi) and Dr. G. S. Murty (New

Delhi); *Secretary*, Dr. M. S. Swaminathan (New Delhi); *Treasurer*, Dr. N. L. Dhawan (c/o Division of Botany, Indian Agricultural Research Institute, New Delhi-12); *Editor*, Dr. B. P. Pal (New Delhi); *Councillors*, Shri P. D. Gadkari (Indore), Dr. B. S. Kadam (Rajkot), Dr. N. Parthasarathy (Cuttack), Dr. Pushkarnath (Simla), Dr. R. H. Richharia (Sabour) and Dr. T. S. Venkataraman (Madras).

University of Birmingham

THE Huxley Lecture for 1956 of the University of Birmingham will be delivered by Dr. Harry Godwin (reader in Quaternary research, University of Cambridge) on February 23, at 5 p.m., his subject being "The Quaternary History of the British Flora". The Sir Josiah Mason Lectures of the University, which have already started, will be continued by Prof. Max Gluckman (professor of social anthropology in the University of Manchester) on successive Thursdays at 5.15 p.m. until March 8, his subject being "Conflict and Cohesion in Zululand". The following have been appointed Research Fellows in chemistry: J. A. Gascoigne and Miss M. Ramsay (British Rayon Research Association Fellows), Dr. H. Weiss, of the Technische Hochschule, Vienna (British Council Research Fellow), and Nadim A. Ghanem, of Alexandria.

Admiralty Student-Apprenticeship Scheme

THE Admiralty has decided to supplement its craft-apprentice scheme by the recruitment of student apprentices who will be selected and trained specifically to meet the Admiralty's requirements of draughtsmen and subordinate technical officers. Student apprentices will be given five years of training in one of the four main dockyards (Chatham, Devonport, Portsmouth and Rosyth), at which basic knowledge of the building and repair of ships will be imparted, and this will be followed by detailed training in the work of one particular branch—naval construction, marine engineering or electrical engineering. Two days a week theoretical instruction will be given in the technical colleges in the Royal Dockyards. A few of the students will be selected for advanced training with the view of their entry into the Royal Corps of Naval Constructors or training as electrical engineers. The Admiralty will continue its long-established craft-apprentice scheme for boys of 15–17 years, and on the basis of their progress during the first year such craft apprentices will be eligible for transfer to the direct-entry student scheme. Student apprentices will be recruited by an open competition conducted annually by the Civil Service Commission; candidates must be 16–18 years of age and will take a written examination in mathematics, physics and chemistry, and English, followed by an interview. The first examination will be held in April, and further information can be obtained from the Secretary, Civil Service Commission, Burlington Gardens, London, W.1.

Announcements

Dr. John Lamb and Dr. J. H. Westcott, lecturers in the Imperial College of Science and Technology, London, have been appointed to University readerships in electrical engineering tenable at that College. The title of reader in anatomy in the University of London has been conferred on D. H. L. Evans and D. A. Sholl in respect of their posts at University College, London.

THE following appointments have been made in the Development and Research Department of the Mond Nickel Co., Ltd.: G. L. Harrison, to succeed A. D. Busby as a development metallurgist in London, where he will work in the field of cast iron; P. D. Wilmot, to be a development chemist in London, where he will be concerned with the chemical and chemico-physical aspects; and J. H. Gittus, to be section leader of the Cast Iron Section at Birmingham.

THE Council of the Royal Society has awarded a Mackinnon Research Studentship to Dr. C. J. Waddington, of the H. H. Wills Physical Laboratory, University of Bristol, for his work on the nature and properties of the primary cosmic radiation.

THE British Museum (Natural History) has received from the Malacca Museums Board a skull of a beaked whale, *Mesoplodon stejnegeri*. This specimen is the first of its kind to be acquired by the Museum, and the species is represented in only one other museum in the world (the United States National Museum, Washington).

THE journal *Vox Sanguinis* is no longer being published by the Central Laboratory of the Netherlands Red Cross Blood Transfusion Service. Publication is now in the hands of the company S. Karger, at Arnold Bocklin-Strasse 25, Basle, to which all inquiries should be sent.

A SYMPOSIUM on vegetable tannins, organized by the Society of Leather Trades' Chemists, will be held in the Chemistry School, Cambridge, during April 12–13 under the chairmanship of Prof. R. D. Haworth and Dr. F. E. King, respectively. Thirteen papers have so far been arranged, including three from workers in Heidelberg; but other papers will be considered if sent in without delay. Registration forms for the symposium and further information can be obtained from the honorary secretary, G. H. W. Humphreys, c/o Forestal Central Laboratories, Harpenden, Herts.

THE third Easter symposium in agricultural science of the University of Nottingham will be held at the School of Agriculture, Sutton Bonington, during April 23–25. The main theme will be the growth of leaves, and the four sessions will deal, respectively, with general aspects of growth and development, initiation and growth of leaf primordia, the expansion of leaves, and the influence of external factors on leaf growth. Further information can be obtained from Prof. F. L. Milthorpe, School of Agriculture, University of Nottingham, Sutton Bonington, Loughborough.

THE Medical Research Council is offering a number of fellowships for the academic year 1956–57, as follows: Rockefeller, Eli Lilly and Lederle travelling fellowships in medicine (2,700 dollars a year or 3,900 dollars for married men), for graduates resident in Great Britain with previous research experience in clinical medicine or surgery, or in some other branch of medical science, to work at a centre in the United States or elsewhere abroad, before taking up positions for higher teaching or research in Britain; Dorothy Temple Cross research fellowships in tuberculosis (£650 a year or £900 for married men), for British subjects to devote themselves to the advancement of knowledge of tuberculosis at a centre outside Great Britain. Application forms (to be returned by March 15) and further particulars can be obtained from the Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1.

CENTENARY OF THE GEOLOGICAL SURVEY IN SCOTLAND

ON January 16 Dr. W. J. Pugh, director of the Geological Survey of Great Britain, and Dr. A. G. MacGregor, assistant director in Scotland, welcomed a distinguished company at a ceremony and exhibition of work, in the Edinburgh office of the Geological Survey, marking the completion of an extension of that office and of a hundred years of Geological Survey work in Scotland. Among the guests were Mr. D. L. Macintyre and Mr. J. MacMinn, of the Ministry of Works, who were responsible for the building operations; Sir Walter Drummond, chairman of the Geological Survey Board, Sir Edward Bailey and Dr. W. F. P. McLintock, former directors of the Survey; Dr. Murray Macgregor and Mr. T. H. Whitehead, former assistant directors in Scotland; professors of geology from the Scottish universities and representatives of Scottish learned societies, professional institutions and government departments, etc., with special geological connexions. The older generations of Scottish Survey geologists were represented by descendants of Dr. B. N. Peach, Prof. James Geikie, Dr. John Horne, Dr. C. T. Clough and Sir John Flett.

Geological Survey work in Scotland commenced in a small way in 1854, at the time when Scottish six-inch-to-mile Ordnance Survey topographical maps began to appear. The first worker, Sir Andrew Ramsay, mapped in Scotland for only a few months. In 1855 his work was continued in the Lothians area, Berwickshire and Fife by H. H. Howell (coalfield areas) and by Sir Archibald Geikie.

Work in Scotland has been successively under the direction of Sir Andrew Ramsay (1854–67), Sir Archibald Geikie (1867–82), H. H. Howell (1882–99), Dr. John Horne (1899–1911), Sir John Flett (1911–20), Dr. Walcot Gibson (1920–25), Dr. Murray Macgregor (1925–45) and T. H. Whitehead (1945–52).

The economic importance of six-inch-to-mile regional geological mapping was early in evidence, for in 1858 Geikie was able to indicate to James Young, founder of the Scottish oil industry, the general distribution of West Lothian oil-shales. The first one-inch-to-mile geological map (Edinburgh Sheet) was published (hand-coloured) in 1859 and the first memoir (Edinburgh District) in 1861. The first six-inch coalfield maps were also published in that year. One-inch maps were coloured by hand up to 1910, when the Edinburgh sheet was one of the first to be colour-printed. The Scottish coalfields were largely covered by 1880. By 1890 the whole of Lowland Scotland, East Highland coastal districts as far north as Dornoch, and part of the North-west Highlands had been published on the one-inch scale.

It was in 1883 that Geikie, in his second year as director general, brought the North-west Highlands under survey. His object was to test conflicting current hypotheses regarding the sequence and structure of the older Highland rocks by carrying out detailed regional mapping in the only area where fossils were known to occur in some of the rocks concerned. The brilliant work of B. N. Peach, J. Horne and their colleagues at once made the region internationally famous for its complex, but clearly demonstrable, tectonic structure. A summary of results was given to the Geological Society of London in 1888, and a monumental official memoir on the region was published in 1907.

Scottish work during 1882–1901 was almost entirely in the Highlands. From that time until to-day, except during the two World Wars, primary Highland survey and revision of coalfield areas have gone on concurrently. The wide knowledge, enthusiastic leadership and literary ability of Dr. John Horne, assistant director during 1901–11, led to a good output of Highland and Lowland maps and memoirs during that period. Sir John Flett's remarkable Scottish petrographic output while petrographer during 1901–11, and his delegation of some petrographic research to others, were of great assistance to Horne. Flett's initiative and drive while assistant director in Scotland (1911–20) and director in London (1920–35) ensured that good progress with the publication of Highland and Lowland maps and memoirs was maintained. The first revision of the main Scottish coalfields and of the West Lothian oil-shale area was complete before 1939; recent economic work has included a second revision of the Lothians coalfield.

During the first three decades of the twentieth century scientific discoveries of fundamental importance to volcanology were among the results of the Survey's Highland work. A. Harker in Skye and Rhum, C. T. Clough, H. B. Maufe and E. B. Bailey in Appin and Lochaber, Clough, Bailey, E. M. Anderson and others in Mull, and J. E. Richey in Ardnamurchan vastly supplemented previous knowledge of Scottish Tertiary and Devonian volcanoes and of volcanic mechanisms in general. Bailey and Maufe also revolutionized ideas on the tectonic structure of the schists of the South-west Highlands.

Pioneer British geophysical work with the Eötvös gravity balance was organized by Sir John Flett and carried out in Scotland by W. F. P. McLintock and J. Phemister between the years 1927 and 1931.

During the First and Second World Wars all available staff were employed on work of economic importance. One result of this activity was the gathering together, for the first time, of a great amount of information on Scottish mineral resources, additional to coal and oil-shale. Much of this geological and mining information has been made generally available by publication. The Survey's geological advice led to the exploitation of virgin deposits of bauxitic clay in Ayrshire, of iron-ore in Raasay, of silica sand in Morvern, of mica in Knoydart and elsewhere, and of potash feldspar in South Harris. These raw materials made notable contributions to the war-time economies of Britain, and in two instances still command a market.

The First World War saw the initiation of a long series of memoirs on the economic geology of the Scottish coalfields. Dr. Murray Macgregor, who was prominent in this undertaking, has done more than anyone else to convince Scottish coalmasters and National Coal Board officials of the practical importance of Geological Survey methods and work. For some thirty years, during twenty of which he was assistant director (1925–45), he encouraged and influenced the constantly expanding economic work of the Scottish Survey.

During the hundred years of Survey work in Scotland, seventy-two memoirs on general and scientific geology, thirty-eight economic memoirs and thirty-six pamphlets on mineral resources, and nine pamphlets on underground water supply have been published. In the thirty years between 1910 and the outbreak of the last War, sixty-nine one-inch maps and ten quarter-inch maps were colour-printed. Sales stocks were destroyed during the Second World War; but since 1945, in collaboration with the Ordnance Survey, every effort has been made to replace the lost maps, while continuing to publish new maps on the one-inch scale and many second revision coalfield maps on the six-inch scale.

As a result of growing recognition of the scope and national importance of the Geological Survey's work, increases of staff followed both World Wars. The most recent expansion is not yet complete enough to balance increased commitments. In Scotland, for example, extensive collaboration with the Scottish Division of the National Coal Board and with the North of Scotland Hydro-Electric Board, the annual incidence of some hundreds of inquiries from other government departments and the general public, and the work involved in republishing colour-printed maps destroyed by enemy action, have prevented the Survey from making rapid progress over the whole field of its activities. A. G. MacGregor

THE TRAINING OF UNIVERSITY TEACHERS

THE question of the advisability and possibility of providing new recruits to university teaching with some initial guidance in the technique of their calling has been examined by S. Radcliffe, lecturer in German at the University of Bristol (*Univ. Rev.*, 28, No. 1; October 1955).

Unlike France, little attention has been paid to the technique of lecturing in Great Britain. In general, lecturers are conscientious about the matter of their lectures, but give little thought to their form or their delivery.

That this can have a detrimental effect on students' work was borne out recently in the Vice-Chancellor's report for 1954–55 to the Convocation of the University of Liverpool. In examining the causes of failure among students taking university examinations, he includes, among "matters about which our consciences ought to be troubled", the following point: "the presentation of a subject in the lecture room, though impeccable as regards content, does on occasion leave much to be desired in the matter of elementary teaching techniques".

This is the most vital point of all. The cause of so much dissatisfaction quite often proves to be some fault in the technique of presentation, or even a mere mechanical shortcoming, which could in most cases so easily have been circumvented by some initial instruction and guidance of the lecturer concerned.

Radcliffe does not claim that teaching is a mechanical craft to be learned in a workshop, but suggests that an artist requires some basic instruction, at least in the rudiments of his craft.

The following are a few of the purely mechanical skills which might be considered desirable in a good teacher or lecturer. First, the adoption of a fitting speed and clarity of diction. Secondly, the clear formulation and appropriate stressing of the main points of the subject under review. Thirdly, the ability to use a blackboard successfully. Fourthly, the 'staging' of material to make it come 'alive'. The correct lighting and ventilation of the lecture room are of importance. A few weeks teaching in any school will bring these and many allied points home.

What is a fitting speed and clarity of diction? How many lecturers ask their students whether they can hear clearly, or whether they are speaking too quickly for them? A teacher can soon learn the correct measure in these instances with the aid of a little guidance. The undue dropping of the voice at the end of each sentence, for example, can produce both monotony and inaudibility. A person with a weak voice can be shown how to make the most of it by someone trained in these matters. This is a problem faced by teacher-training departments.

The clear formulation and appropriate stressing of the main points of the subject cover a large number of factors. Just as the potential teacher must learn how to arrange and present the various points he is intending to convey in a lesson, so must the lecturer have a clear and systematically arranged plan of what he intends to talk about. He must know which points are important or difficult enough to require particular stressing, either in the form of repetition or slower and more deliberate speaking, or even by the dictation of vitally relevant matter.

The extent to which the blackboard is used will obviously vary with the nature of the lecture; a statistical, technical or linguistic theme will call for more blackboard writing than, say, a literature or philosophy lecture. Titles of works, proper-names, unusual or foreign terms, dates—all these should be written up to ensure that students get the correct form. The writing must be clear and legible, and not scattered about in disorder on the board.

Lastly, Radcliffe elucidates his reference to the proper 'staging' of material. There is an element of the histrionic in all personal teaching; the teacher is to some extent an actor, who must make his material come to life. There are some generally recognized devices into the application of which the tyro could with advantage be initiated. A slight break before passing on to a new theme in a lecture can be most refreshing for all concerned. An occasional pause to receive questions from students will in certain cases add to the effectiveness of the lecture; it "draws the students in" more and gives the lecturer a chance to gauge their grasp of what he is saying. Learning the students' names is an essential requirement in establishing such closer contact with them. The prompt return of written work not only helps to keep up students' interest in their subject, but also gives the right to demand written work from the students within the time-limit specified.

MORPHOGENETIC STUDIES OF *DRYOPTERIS*

IN two studies, the growth, organization and morphogenetic activity of the shoot apex of *Dryopteris aristata* have been further investigated by experimental means. C. W. Wardlaw and E. G. Cutter (*Ann. Bot.*, 19, 76, 515; 1955) have observed that when the apical cell-group is damaged, leaf

primordia, which may be orientated abnormally, continue to be formed on the meristem; but one or more buds may also arise. The observations reported here indicate that a zone at the periphery of the apical meristem is particularly reactive when the apical cell group is damaged, the majority of buds being induced in this region. The extent of damage to the apex may affect the sequence of organogenesis: when damage is extensive buds tend to be formed immediately, subsequent primordia developing as leaves; when the damage is confined to the apical cell, or extends to only a few of its segments, bud formation tends to be delayed. It is concluded that the effect of the apical cell on organ formation is exercised through the growth and organization of the apex as a whole.

E. G. Cutter (*ibid.*, 485) has also observed that in the shoot apex in *Dryopteris aristata*, maintained under conditions of progressive starvation for periods up to a year, the apex decreases very markedly in size; the size of leaf primordia at their inception decreases, but their size relative to the shoot apex increases; the rate of inception of leaf primordia decreases; the rate of morphological development of leaf primordia increases; there is a reduction in the system of phyllotaxis towards that characteristic of sporelings; the vascular system of the attenuated axes is dictyostelic, but there is a reduction in the number of meristeles in the axis and in the leaves.

THE SCIENTIFIC CIVIL SERVICE

PROMOTION OF INDIVIDUAL RESEARCH WORKERS

SPECIAL posts have been created in the Scientific Civil Service, as in previous years, under provisions included in the White Paper (Cmd. 6679: 1945), designed to provide for the promotion of individual research workers of exceptional merit. The promotions are effective from July 1, 1955.

Chief Scientific Officer

Dr. P. B. Walker spent five years as a designer in the aircraft industry after postgraduate research in the University of Cambridge on fluid motion. Then in 1935 he joined the Royal Aircraft Establishment, Farnborough, and was a pioneer of the rational scientific approach to aircraft structural design in place of the old empirical formulæ. During the Second World War he was responsible at the Ministry of Aircraft Production for the supervision of the design of gliders and paratroop aircraft. Dr. Walker returned to the Establishment in 1945 as head of the Structures Department, where he concentrated on building up first the Flutter Division, and secondly the Aircraft Structural Fatigue Division, into flourishing teams with widespread reputations. In particular, his work on aircraft fatigue was of great importance in connexion with the investigation of the Comet aircraft, for which he was made C.B.E. In 1951 he delivered the Wright Brothers Lecture in Washington, D.C.

Deputy Chief Scientific Officers

Mr. E. H. Cooke-Yarborough entered government service in 1940 and worked on the development of airborne radar. Later he concentrated on radio counter-measures and also on guided weapons. In 1946 he became interested in atomic energy, and eventually joined the Atomic Energy Research Establishment, Harwell, where he is at present deputy head of the Electronics Division. Mr. Cooke-Yarborough is well known as a specialist in the design of electronic circuits, and during recent years he has been associated with the design of digital computers and the use of transistors; a new computer employing transistors as circuit components is now in use at Harwell.

Mr. B. Sykes joined the Royal Aircraft Establishment, Farnborough, in 1925 from the Imperial College of Science and Technology, London, and his early work was in the field of aircraft electrical engineering, covering such problems as electrically heated flying clothing and the design of a self-regulating generator for aircraft. During the Second World War he played a considerable part in the design and setting up for production of predictor gunsights, and since the War he has been increasingly concerned with general problems of air fighting.

Dr. P. C. Thonemann graduated from the University of Melbourne in 1940 and worked first at the Munition Supply Laboratories, Victoria, and then at the Research Laboratories of Amalgamated Wireless of Australasia, where he was concerned with propagation problems. Later he gained a Commonwealth research fellowship at the University of Sydney, studying physical phenomena in ionized gases, and assisted in the development of gas-discharge modulator switches. At the Clarendon Laboratory, Oxford, he continued to study gas-discharge phenomena and their applications in nuclear science, and this led to the production of the radio-frequency type of proton source which is now used almost universally in laboratories equipped with high-voltage sets for the acceleration of ion beams. Since 1949 he has directed the work of a group investigating the properties of highly ionized gases.

Dr. D. Williams entered the Royal Aircraft Establishment, Farnborough, in 1924 from industry, where he had served as a pupil apprentice after graduating in mechanical engineering from University College, Cardiff, in 1922. Following a few years on stress calculations and the supervision of experimental aircraft contracts, he began work in 1930 on aeronautical structural research. During recent years his research has covered a wide field, including the first complete mathematical theory of 'sandwich' construction, the response of aeroplane structures to dynamic loading, aero-elastic calculations, pressure-cabin problems, and the dynamic instability of systems incorporating pneumatic-tyred wheels.

Senior Principal Scientific Officers

Mr. G. K. Adams graduated in chemistry from the University of Bristol in 1942 and then joined the Armament Research Department of the Ministry of Supply, where until the end of the Second World War he worked on the thermal decomposition of explosives and the evaluation and combustion of pyrotechnic compositions. In 1946 he joined the Explosives Research and Development Establishment, where he has carried out theoretical and experimental researches on combustion processes, especially on rates of flame propagation and of chemical reactions in flames.

Mr. R. Benjamin graduated in 1944 from the Imperial College of Science and Technology, London, and immediately joined the Admiralty Signal and Radar Establishment, where he is still serving. He has been mainly concerned with research in the fields of radar and electronics, and is the author or co-author of some ninety scientific reports and memoranda ranging from circuit design to the evolution of complete new radar systems. For security reasons the more important of his researches have not yet become available for open publication; but his theoretical ability and his exceptional skill in the practical solution of complex electronic problems are well known among workers in this field.

Mr. G. F. Clarke entered the electronics industry on graduating from the University of Birmingham in 1928, and after holding several posts he joined the Bawdsey Research Station in 1938, whence he went to the Radar Research and Development Establishment. Eight years later he transferred to the Royal Aircraft Establishment, where much of his work has been concerned with radar and guided weapons, but has not been published. As an investigator and adviser on widely varied problems, his knowledge combines both theory and practice.

Mr. D. R. Davies graduated in chemistry from University College, Cardiff, in 1924 and held a number of appointments in biochemical and medical research covering such subjects as the biochemical aspects of mechanisms of detoxication, brain enzyme systems with particular reference to narcotics, the metabolism of drugs in abnormal mental states, phosphatase of spleen and blood, and studies of physique and mental disorders. During the Second World War he held a commission and worked for the War Office on the analysis of causes of casualties and assessing the efficacy of therapeutic measures. He joined the Chemical Defence Experimental Establishment in 1947, where he has built up a flourishing biochemical section and has become a leading authority on the cholinesterases and their inhibitors.

Mr. R. A. Fairthorne joined the Royal Aircraft Establishment, Farnborough, in 1927, and six years later gained a first-class honours degree in mathematics as a result of private spare-time study. Of the many facets of his work, mention may be made of his studies on scientific and mathematical films, library organization and bibliography, the use of commercial punched-card techniques for scientific computing purposes and the application of statistical methods to aeronautical research. During recent years his notable work has been done on the theoretical principles underlying the handling, classification and communication of technical information.

Dr. A. F. Gibson joined the staff of the Telecommunications Research Establishment, Malvern, after graduating in physics from the University of Birmingham in 1944, but remained at Birmingham for research on luminescence in solids in collaboration with Dr. G. F. J. Garlick. He went to Malvern in 1948, working originally on infra-red photo-conductors, and in 1951 he took charge of the newly formed transistor physics research group. He is an outstanding experimentalist, equally at home in both pure and applied physics.

Dr. G. N. Harvey began his career as an officer in the Royal Navy, in which he again served during the Second World War, having in the meantime acquired both business and industrial experience. During his naval service he was closely associated with degaussing and was made O.B.E. In 1945 he joined the Admiralty Compass Department and worked on the theory and correction of errors in compasses. In 1947 he joined the Fighting Vehicles Research and Development Establishment, and there he has made important advances in such different fields of applied research as optics, navigational systems and servo-mechanisms.

Mr. C. E. Hubbard first went to the Royal Botanic Gardens, Kew, in 1920 as a student gardener and soon after became a technical assistant in the Herbarium under Dr. Otto Stapf, an authority on grasses. On the latter's retirement, Mr. Hubbard was appointed to take charge of this group, which he has made his special study ever since. He spent six weeks studying the flora in Spain in 1924 and a year in Australia during 1930–31 to assist the Queensland Government in the study of the indigenous grasses. He was made O.B.E. for services to science and agriculture in 1954.

Dr. J. L. King joined the Admiralty Research Laboratory in 1942 after studying mathematics in the University of Cambridge, and four years later was assimilated into the newly formed Royal Naval Scientific Service. Dr. King is the author of some twenty scientific reports ranging in subject-matter from hydrodynamics to atomic weapons, most of which, however, have not been published because of security regulations. One notable exception is a dissertation "On the Motion of an Elastic String", which is a basic study related to aircraft catapults. In the near future Dr. King will be returning to the hydrodynamics field as leader of a team which will be primarily concerned with fundamental theoretical investigations into the motion of bodies under water.

Dr. W. J. Kramers studied chemistry at the University of Oxford, and before joining the Ministry of Supply in 1949, he held appointments in industry and at the British Coal Utilization Research Association. His work in the Armament Research Establishment, and more recently the Atomic Weapons Research Establishment, is centred on the development of new ceramic materials. He was responsible for the development and preparation of cerium monosulphide—a material which had not been studied in Britain previously—and other novel ceramic compositions including various metal oxides; this latter work has led to the possibility of developing new high-temperature ceramics.

Dr. F. P. O. Kubaschewski joined the National Physical Laboratory, Teddington, in 1947, where he has made thermodynamical investigations concerning the possibilities of new methods of producing titanium, vanadium and zirconium. He has also been interested in the thermochemistry of metallic alloys in relation to the phase equilibria existing in metallic systems, and has developed novel methods of measuring directly the heats of formation of alloys in the solid state which are of importance in connexion with the mechanism of bonding. He is the joint author, with Mr. E. Ll. Evans, of "Metallurgical Thermochemistry" and, with Mr. B. E. Hopkins, of "Oxidation of Metals and Alloys".

Mr. W. Lawrence took the Mechanical Sciences Tripos at the University of Cambridge in 1926, and then spent several years in radio transmission work in industry. He joined the Signals Research and Development Establishment of the Ministry of Supply in 1941, where he worked originally on the development of mobile telecommunications equip-

ment, and later on cables and special measuring apparatus. During recent years he has been concerned with research on data transmission and speech problems, and in the field of speech synthesis, in particular, his scientific understanding and experimental skill have led to notable advances.

Dr. Roy Markham joined the staff of the Agricultural Research Council Virus Research Unit in 1940 after graduating from the University of Cambridge. His work has been mainly concerned with the biochemistry of viruses, and in particular the function of nucleic acids in virus nucleo-proteins. He has been responsible for the development of a number of techniques for the analysis of nucleic acids and the determination of their structure.

Mrs. B. Naylor, who is a graduate in electrical engineering of the University of Manchester, entered the Royal Aircraft Establishment, Farnborough, in 1936, where for much of her career she has been concerned with research on aircraft engines and accessories and test-plant for them. During more recent years she has worked on combustion problems, on ram-jet development, and on the cooling of supersonic aircraft. She is a qualified pilot and therefore brings first-hand knowledge to the aircraft problems with which she deals. She was made O.B.E. in 1949.

Dr. K. P. Oakley, of the Department of Geology, British Museum (Natural History), is an authority on human and near-human fossil remains, his handbook, entitled "Man the Tool-Maker", on the British Museum's post-war exhibition on man as a tool-making primate being widely used in British and American universities. In co-operation with the staff of the Government Chemist's Department, he has investigated the geological age of a number of fossil human remains of disputed age by fluorine-dating and other methods, and has obtained some remarkable results. In 1953 Dr. Oakley investigated fossil Hominid sites in South Africa and obtained data bearing on the age of the Australopithecines and the Rhodesian and Saldanha skulls.

Dr. G. M. Roper studied mathematics at Cambridge and then was a school-teacher for several years before becoming a mathematics lecturer at the Chelsea Polytechnic in 1941. After doing aerodynamics research in her spare time at the Imperial College of Science and Technology, London, for which she gained a Ph.D., she joined the Royal Aircraft Establishment in 1941, where, in addition to being in great demand as a mathematical consultant, she has done valuable research in the theory of supersonic flow, especially in the study of delta and swept-back wings.

Dr. W. B. Thompson graduated in mathematics and physics from the University of British Columbia in 1945 and later gained his Ph.D. at the University of Toronto for a thesis on thermal convection and the Earth's magnetic field. After part-time research at the Chalk River Laboratories on the energy distribution of plutonium fission fragments, he went to Britain with a senior research fellowship at Harwell, where he has been mainly concerned with the theoretical analysis of the physical properties of highly ionized gases. In addition, he has published papers on thermal conduction in magnetic fields and on the acceleration of cosmic-ray particles.

Dr. D. P. Wilson has been engaged in research at the Plymouth laboratory of the Marine Biological Association since 1926. He first studied extensively the development of polychaete worms, and this led him to examine the external factors controlling settlement and metamorphosis. He has also shown that sea water from some areas is less favourable for larval development than that from others, thus making more understandable the regional differences in the distribution of different species of bottom-living animals. Dr. Wilson is a graduate of the University of Manchester, gaining his doctorate in 1949.

Mr. F. P. W. Winteringham's work at the Pest Infestation Laboratory of the Department of Scientific and Industrial Research has led to the application of radioactive tracer and paper-chromatographic techniques to two lines of investigation concerned with the use of insecticides in the protection of stored foodstuffs: the contamination of food resulting from treatment with fumigants and contact insecticides; and the study of insecticidal action within the body of the insect. In connexion with the latter it has been found possible to label not only the insecticide under investigation but also the enzymes and metabolites in the living insect. This makes it possible to isolate and determine quantitatively, by chromatographic techniques, the component parts and by-products of different metabolic cycles, first in the normal insect and then in the insect affected by the insecticide.

OCCURRENCE OF *BEIJERINCKIA* SPECIES IN THE 'PHYLLOSPHERE'

By Dr. J. RUINEN

Treub Laboratory, Kebun Raya Indonesia, Bogor

In 1949 Derx[1,2] started an investigation into the occurrence of nitrogen-fixing organisms in tropical soils—a question up to then much disputed; but after incidental research in the first half of the century once more of importance in view of the increasing need of fertilizers in a region notoriously poor in nitrogen. After establishing the carbohydrate source and *p*H required for their culture, Derx succeeded in isolating a number of nitrogen autotrophic bacteria from soil and water, namely, *Azotobacter chroococcum* Beijerinck, *A. vinelandi* Lipman, *A. agilis* Beijerinck and *A. indicum* Starkey et De. The last-mentioned species was segregated from the others and placed in the new genus *Beijerinckia* because of differences in the physiological, cultural and morphological properties. The presence of *B. indica* (Starkey et De) Derx and *B. mobile* Derx has been demonstrated in the acid and slightly alkaline soils of Indonesia, of Nigeria, of the savannahs of the Belgian Congo, of the upland rice-fields in Tonga, and of the rice-fields of Surinam[3]. A similar occurrence was reported by Kluyver and Becking[5]. Besides the first isolations from Indian[6] and Malayan[7] soils, the presence of *Beijerinckia* in soils in the tropics, in particular North Australia, was reported by Tchan[8], while Döbereiner cultivated

many strains of *Azotobacter*[9] and *A. indicum*-like organisms abundant in acid Brazilian soils (personal communication). *Beijerinckia* has never been reported outside the tropics. It could not be isolated from the soils of temperate zones[6] or from the soils in nurseries in Holland where tropical conditions were maintained during the summer months. Derx[4] suggested that the occurrence of *Beijerinckia* might be due to a possible association with specific tropical vegetation, presumably leguminous plants, or rice, because cold storage does not affect the viability appreciably and the habitats so far reported are all tropical. Kluyver and Becking, on the other hand, pointed out that the prevalence of *Beijerinckia* in lateritic formations and not in other soil types may explain why until now it has been found only in the tropics.

During the period of Derx's research on nitrogen fixation I[10] was studying the interrelation between the different components of the epiphytic vegetation in Indonesia. The main object of these studies was a small epiphytic fern, *Drymoglossum piloselloides* Presl, common not only on trunks and branches, but also having a tendency to settle on leaves, to which it attaches itself by spreading roots and root hairs. Its occurrence in this habitat might be explained by the cuticular excretion of the leaves. It is a striking fact that trees overgrown by this epiphyte decline; and it was proved in a number of cases that fungi living in the rhizosphere of the fern infect the tree-support and cause the die-back of the branches.

In searching for the organisms which might be responsible for this decline and which might, eventually, account for the presence of higher epiphytes, an analysis was made of the rhizosphere-vegetation of the latter. During the years 1952–54 the relation between seven different tree-supports, including barks with rough and smooth surfaces, and ultimately the leaves, and two epiphytes was examined microbiologically. A routine comprising observation under low magnification and plate-culture was followed. Taking the limitations of the method into account, it nevertheless became evident that: (1) in the rhizosphere the fungi prevailed over the bacteria; and (2) in the adjacent areas the bacterial flora was richer. Microscopical observation showed that the fungi were mostly common soil fungi and mild parasites.

The second point, the prevalence of bacteria in the areas not covered by the epiphyte, was investigated in more detail. For this the anatomically simpler leaf surface seemed preferable to the complicated periderm. The same difference in microbe distribution was found. Moreover: (1) the fungal population increased with the age of the leaves; it was practically absent on young ones and became abundant on senescent ones; (2) the bacterial population similarly increased with age, becoming abundant as soon as the leaf was full-grown; (3) the ratio fungi : bacteria was lowest on the full-grown leaf, but appeared to increase on older leaves; (4) the species of bacteria and yeasts in the epiphyllic population seemed characteristic and limited in number; (5) among the bacteria *Mycoplana rubra* (Den Dooren de Jong) Derx et De Vries and *Beijerinckia* sp. occurred frequently; (6) the time of soaking and shaking the leaves before plating influenced the plate-count.

These observations suggested the existence of a characteristic milieu which is conditioned by the leaf, and may be called, in analogy with the rhizosphere, the 'phyllosphere'. (Since the completion of this communication I have seen the article on fungus incidence on cereal leaves in which Last also introduces the term 'phyllosphere' in the same sense (*Trans. Brit. Mycol. Soc.*, **30** (3), 221; 1955).)

As this phyllosphere apparently is a favourable habitat for *Beijerinckia*, more leaves were examined. Leaves from trees and shrubs of different ecological groups collected in different localities in Java, Sumatra and Banka were studied. The sources of the material comprised trees up to 24 m. in height, free-hanging tendrils of climbers, crater-plants, epiphytes and coastal vegetation. The epidermis was examined directly under 900 times magnification. Furthermore, a simple bacterial enrichment technique was used—virtually a modification of Winogradsky's starch method. In 192 out of 196 cases *Beijerinckia* was observed. In a saturated atmosphere at room temperature (varying from 26° to 32° C.) the bacteria appear within twenty-four hours; later they become overgrown by other bacteria, yeasts and fungi, but when this vegetation declines after having exhausted the original medium, *Beijerinckia* colonies emerge from the debris.

The apparent omnipresence of *Beijerinckia* on leaves as a component of a typical vegetation, characterized *inter alia* by a number of slime-producing organisms, opens a new field of tropical botanical and microbiological research.

The importance of the nitrogen-fixing property of *Beijerinckia* has already been demonstrated in the ecological relationship with blue-green algae in rice-fields. It may prove to be still more important in the phyllosphere. It seems quite plausible on one hand that the stream of nutrient salts and metabolites excreted by the cuticle serves as the nutrient medium of the epiphyllic micro-vegetation, while on the other hand the nitrogen fixed by *Beijerinckia* might offer a constant and essential source of bound nitrogen. The latter may be taken up directly by the leaves in the diurnal rhythm of water-content variation, and then transported through the plant body itself. It also may be washed off by the rain together with the leaf excretions and via the soil reach the ordinary upward nutrient stream. A second cycle of nitrogen-fixation in the soil and decomposing leaf litter may support the first-mentioned one.

This may imply that the inexhaustible reserves of atmospheric nitrogen and carbon dioxide in conjunction with the climatic conditions are ultimately the cause of the luxuriant tropical vegetation through the interrelationship of these bacteria and the green plants. Eventually it might explain the wide distribution of *Beijerinckia* throughout the tropics. A closer study of the phyllosphere and the occurrence of *Beijerinckia* and other micro-organisms in this milieu will be important for agriculture and forestry.

The preliminary work and further considerations on this problem will be published in the *Annales bogorienses*.

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SPECTROCHEMICAL ANALYSIS WITH TIME-RESOLVED SPARK SPECTRA

By Dr. Á. BARDÓCZ and F. VARSÁNYI

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IT is well known that the main advantage of the high-voltage electric spark as a spectrochemical light-source is that its analytical accuracy is in general the highest of all light sources. Its disadvantage, however, is that its sensitivity is low, which is mainly due to the fact that the spectrum of the electric spark has a continuous background, in which weak spectral lines cannot be observed. Even if the spectrum line/background ratio is high, the background is still highly disturbing in the evaluation of intensities.

It is known from earlier investigations that the background of spark spectra appears in the initial stage of the discharge; in the subsequent stages of the spark the spectrum is practically free from background. Steinhaus, Crosswhite and Dieke[1] introduced a photoelectric procedure, by means of which this background can be separated from the spectrum. We have developed a method by which the background is separated by optical means. This method is capable of giving spectra practically free from background. To this end a high-precision spark source and an optical arrangement containing a rotating mirror are needed. The spectrum may be detected either photoelectrically or photographically.

The optical arrangement is shown in Fig. 1. The reduced image of the light source A is formed on the slit $S2$ by means of the concave mirror M fastened to the shaft of the synchronous motor C. The slit $S2$ is parallel to the plane of the figure, and selects a part of the time-resolved image of the light source. An image of the slit $S2$ for the collimator lens of spectrograph D is obtained by means of lens L. $S1$ denotes the slit of the spectrograph and P the photographic plate.

As the production of a single spectrum requires an exposure of a few minutes, that is, the light of several thousand spark discharges, in order to obtain the result desired, the time-resolved image of the individual sparks must be precisely formed at the same point of the plane of slit $S2$. In other words, the problem requires the precise synchronism of the rotation of the mirror and the initiation of the individual spark discharges. The problem is solved by means of the electronically controlled spark-source introduced by Bardócz[2], in which the spark discharge is initiated with a jitter of a few tenths of a microsecond with respect to a controlling signal. The spark source is controlled by the amplified voltage signal of photocell I illuminated by the lamp H at each turn of the rotating mirror M.

The image of the light-source A is adjusted on the slit $S2$ by setting the lamp H or the photocell I perpendicular to the plane of the figure.

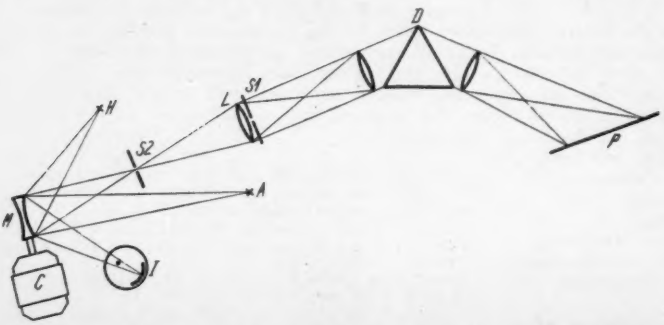

Fig. 1. Optical arrangement for spectrochemical analyses with time-resolved spectra

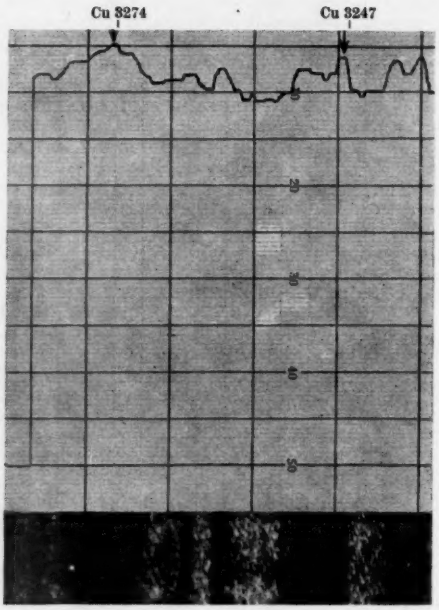

Fig. 2. Lower part: Cu 3274 and Cu 3247 lines in the spectrum of aluminium containing 0·01 per cent copper. Upper part: density curve of the above spectrum as scanned by a recording microphotometer. Magnification of the spectrum, 25 ×

To illustrate the advantages which can be achieved by the above procedure in spectrochemical analysis, Fig. 2 shows part of the spark spectrum of aluminium containing 0·01 per cent of copper, taken in the usual manner, with background. The upper part of Fig. 2 shows the density curve of the spectrum scanned by a recording microphotometer. Fig. 3 shows the same part of the spectrum as photographed by the method described here. The difference between the line density/background density ratios in the two figures is striking. The deflexion of 50 is in both cases that corresponding with the unexposed plate.

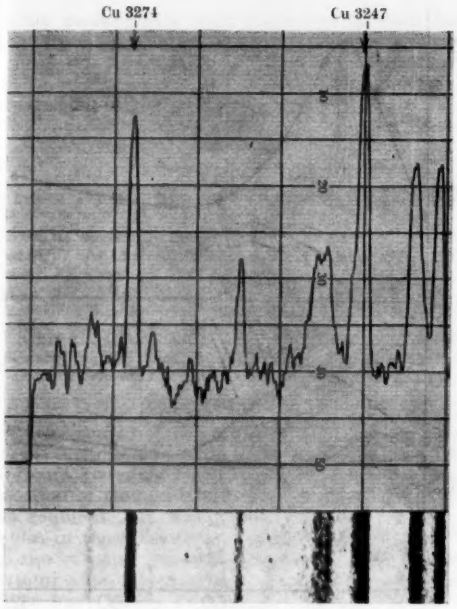

Fig. 3. Lower part: Cu 3274 and Cu 3247 lines in the time-resolved spark spectrum of aluminium containing 0·01 per cent copper. Upper part: density curve of the above spectrum as scanned by a recording microphotometer. Magnification of the spectrum, 25 ×

In taking the spectra of Figs. 2 and 3, the capacity of the condenser of the spark source[2] was 10,000 pf., its charging voltage 20,000 volts, and the frequency of the spark 50/sec. One of the electrodes was aluminium rod containing 0·01 per cent copper and other impurities, and the other a spectroscopically pure carbon rod. The electrode separation was 3 mm. The photographs were taken with a medium-size spectrograph, on Agfa Blau rapid plates. The slit width of the spectrograph was 30 microns. The exposure time of Fig. 2 was 1 min. and that of Fig. 3, 4 min. These exposure times were chosen so that in both spectra the strongest density should be about the same.

The photographs reproduced in Figs. 2 and 3 were taken with the same equipment, except that in the case of Fig. 2 the mirror was still, whereas in the case of Fig. 3 it rotated with a frequency of 3,000 revolutions/min. One side of the mirror was coated with aluminium and the other with dull black paper. The distances A–M and M–$S2$ were 403 mm. and 325 mm. respectively. The radius of curvature of the mirror is 360 mm. The travelling speed of the image of the light source on the screen $S2$ was 0·204 mm./microsec. In taking Fig. 3, the light emitted by the spark between 29 and 54 microsec. was used.

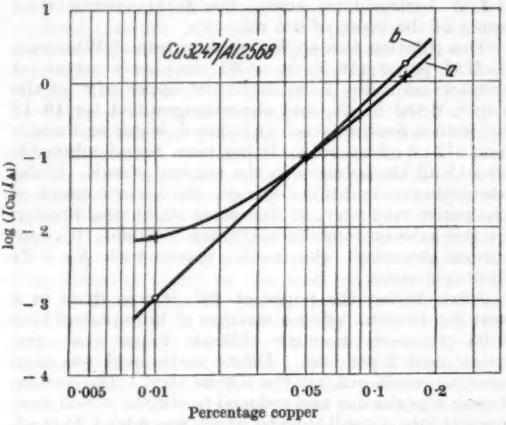

Fig. 4. Analytical curves for the determination of copper in aluminium. Curve a: taken in the usual manner. Curve b: initial stage of the discharge cut out

Fig. 4 shows two analytical curves for the determination of copper in aluminium. One of the curves (a) was taken in the usual manner and the other (b) with the initial stage of the discharge cut out. The Cu 3247 and Al 2568 lines were used for plotting the analytical curves. [July 23

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PAPER CHROMATOGRAPHY OF INSULIN

PREPARATORY to carrying out experiments on the incorporation of labelled amino-acids into insulin in beef pancreatic slices, it was necessary to design some method which would allow of the isolation and determination of the insulin in small amounts of tissue with reasonable accuracy and speed. In view of the rather unusual solubility properties of this protein, it appeared possible that some chromatographic separation might be feasible. Several investigators have carried on work of this kind. Porter[1] separated pure insulin from crude preparations by using a silane-treated silica gel column; Porath and Li[2] used a charcoal column successfully. Others have tried to separate various proteins by paper chromatography. Sanger[3] did not obtain notably good results with insulin fractions A and B because of streaking. However, Robinson and Fehr[4] were able to estimate the percentage of insulin in protamine insulin by using the upper phase from a butanol/acetic/water (3 : 1 : 4) mixture as a chromatographic solvent.

After trying various solvent combinations, we likewise found it possible to isolate insulin from the major part of the contaminating protein by using a similar mixture of butanol, water and acetic acid in a single phase. Insulin on the paper was then determined by staining and reading the depth of colour of the eluate as described below. The preliminary extraction and purification of insulin were carried out by standard methods, with slight modifications[5].

The proteins in about 1 gm. of hashed tissue were precipitated by the addition of 25 ml. of 6 per cent trichloracetic acid. After homogenization, the protein was centrifuged down and washed with trichloracetic acid (5 per cent, 1 ml.). The precipitate was extracted twice at 37° for 2 hr. by shaking with

4-ml. portions of an acidic solvent (15 ml. ethanol, 5 ml. water and 3 ml. concentrated hydrochloric acid), and the *p*H of the combined extracts was adjusted to 8·5–9 with concentrated ammonium hydroxide, after which they were allowed to stand in the cold. Any precipitate was discarded after washing with ammoniacal alcohol. Insulin in the alcoholic solution (about 10 ml.) was precipitated by the addition of about 40 ml. of an alcohol–ether mixture (3 : 5 by volume), and allowing to stand in the refrigerator. After washing this precipitate of crude insulin with alcohol, the soluble part was taken up in 0·3 ml. of the acidic solvent, to which was added 0·1 ml. of 0·1 *N* hydrochloric acid; the total volume then being of the order of 0·5 ml.

This solution was applied to a curtain of Whatman 3 *MM* paper (46·5 cm. × 67 cm.) as a streak of droplets on a line 7 cm. from the upper edge of the paper, dried in air, and chromatographed for 10–12 hr. with a fresh mixture of butanol, water and acetic acid (12 : 5 : 2 by vol.). It has been found advisable to add all the solution in the original streak. If the atmospheric conditions change, the water content of the paper may vary, so that some slight modification in the solvent may be necessary. Under the conditions described, the insulin moves with R_F 0·21 approximately.

After drying the paper at 40°, it was dyed in a tray for 10 min., using a mixture of bromphenol blue 0·05 per cent, mercuric chloride 1 per cent, and acetic acid 2 per cent. Dilute acetic acid was then used to wash out all the excess dye. The insulin streak was cut out and reduced to shreds, which were packed into a small tube to which was added 25·0 ml. of the acidic solvent. After extracting for 45 min., samples were removed, centrifuged to get rid of any paper and the depth of colour determined at 470 mμ. The actual amount of insulin was determined by comparing the colour with that from insulin standards treated in exactly the same fashion. A linear relationship existed between the amount of dye eluted and the amount of insulin applied to the paper in the range 0·1–2·0 mgm. of insulin.

The results of chromatographing liver proteins against insulin with five different solvent systems are shown in Fig. 1. This provides the reason for the selection of the solvent system used. It also indicates that there is probably no significant amount of other protein in the liver extract which behaves like insulin when the proper solvent combination is used. None of a series of other proteins tried, including ribonuclease and serum proteins, behaved as did insulin;

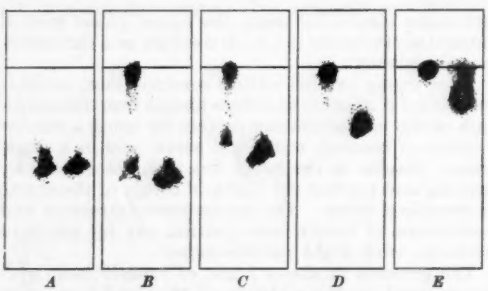

Fig. 1. Chromatography of insulin and extracts of liver. The left-hand spot of each pair is insulin. The solvent mixtures are made up with the following proportions of butanol, water and acetic acid: *A*, 6 : 2 : 0·64; *B*, 6 : 3 : 1·2; *C*, 6 : 4 : 1·52; *D*, 6 : 5 : 1·72; *E*, 6 : 6 : 3·4. All solvent systems comprised a single phase

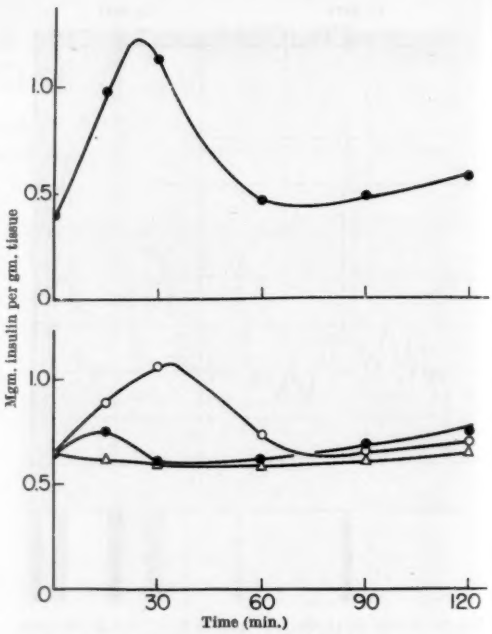

Fig. 2. Changes on insulin content of fœtal beef pancreas following incubation under various conditions

Upper curve: Incubation in 95 per cent oxygen, 5 per cent carbon dioxide. Lower curves: open circles, conditions as for upper curve; closed circles, incubation under 95 per cent nitrogen, 5 per cent carbon dioxide; open triangles, under oxygen in the presence of 10^{-4} *M* dinitrophenol

although there are indications that glucagon may have very similar properties.

When insulin was added to an acidic solvent-extract of liver, prepared as indicated above, the recovery of the insulin varied between 92 and 93 per cent, the acidic extract itself containing no detectable amount of the hormone. Insulin recovered from chromatograms was biologically active and when subjected to electrophoresis on paper using veronal buffer (0·05 *M* at *p*H 8·6) it behaved precisely as did insulin.

1-gm. samples of fœtal beef pancreatic slices were incubated in the pyruvate–bicarbonate buffer (*p*H 7·6) described by Anfinsen[6] and the changes in insulin content over a period of two hours at 37° were measured by the method just described. Fig. 2 shows the results when the incubations were carried out in the presence and absence of oxygen and with the addition of dinitrophenol. With oxygen present, the insulin content of the tissue increased during the first 30–40 min. of incubation, but later there was a decrease. In the absence of oxygen no such phenomena occurred. Whether these results are to be attributed to the net synthesis of insulin during the first part of the incubation period, or to the formation of insulin from some precursor, is not clear.

When slices were incubated for 30 min. in the presence of 0·2 per cent glucose, there was an increase in insulin content of 65–72 per cent. Glucose appeared to have a direct effect on insulin production by slices, as it has on the perfused pancreas[7]. Work is in progress to determine if this is an effect of synthesis or secretion, and to determine the effect of other carbohydrates and hormones on insulin production.

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In the course of the development of a procedure for the small-scale isolation of labelled insulin from surviving pancreas slices, a rapid method for the detection of this protein in crude pancreas fractions was required. It was found that the presence of insulin in these fractions could be demonstrated by the use of paper chromatography, and that protein contaminants, when present, were readily detectable in the more highly purified insulin samples. Moreover, further studies showed that this chromatographic procedure was suitable for routine use as a preparative method which then replaced the lengthier procedures[1,2] originally investigated. Hitherto, only the paper chromatography of pure crystalline insulin[3] and pure protamine insulin[4] have been reported.

A large number of solvent systems were tested with crystalline insulin on Whatman No. 1 paper, using descending chromatography. Results obtained with the satisfactory systems are reported in Table 1. In most cases, systems containing 2-butanol gave excellent results, with 2-butanol/1 per cent (v/v) acetic acid (1 : 1) giving the most discrete spots. 20 μgm. of insulin is easily detectable. Some of the properties of this system for crystalline insulin and for crude and partially purified pancreas extracts are reported below.

The R_F of crystalline insulin in this system varies with the amount applied to the paper and with the distance travelled by the solvent front. The following R_F values were found for the corresponding amounts of insulin (given in μgm. in parentheses): 0·33 (200), 0·32 (160), 0·30 (120), 0·27 (80). The dependence of R_F on the distance travelled by the solvent was studied by spotting the insulin solution along an oblique line according to the method of Bowman[6]. The following R_F values were found for the corresponding distances (given in cm. in parentheses) travelled by the front: 0·30 (28·5), 0·29 (25·9), 0·26 (23·2), 0·24 (20·6), 0·23 (17·6), 0·23 (14·9). The R_F values at 0° and at 25° were the same. Ascending chromatograms gave substantially lower R_F values than descending.

Table 1. R_F Values of Insulin in Various Solvent Systems

Solvent system	R_F
2-Butanol/1 per cent acetic acid (1 : 1)	0·30
2-Butanol/1 per cent dichloracetic acid (1 : 1)	0·29
2-Butanol/acetic acid/water (4 : 1 : 5)	0·92
2-Butanol/formic acid/water (4 : 1 : 5)	0·90
1-Butanol/acetic acid/water (4 : 1 : 5)	0·29
Phenol/water (4 : 1)	0·95

The numerical ratios given in column 1 represent the proportions of the volumes of solvents which were mixed. Where two phases resulted, the organic phase was used and the aqueous phase discarded. 50 μgm. of insulin dissolved in 0·05 *N* hydrochloric acid was used in most cases. The positions of the spots were determined by the bromphenol blue method (ref. 5). Development was stopped when the solvent front had moved about 30 cm.

The paper chromatographic technique described here for pure insulin could be used to detect the presence of this protein in the various crude fractions obtained from the procedure of Romans *et al.*[1] provided that the sample to be chromatographed is first dialysed free of salt and that an excessive amount of crude protein is not put on the paper. The amount of insulin present could be estimated approximately by comparison with known insulin spots. Ribonuclease, serum albumin, or pancreas fractions depleted of insulin show no movement. However, crystalline glucagon moves at the same R_F as does insulin. Its presence in insulin samples may readily be detected by paper electrophoresis at *p*H 7·5[7].

For preparative purposes, a modification of the chromatographic procedure was necessary. In the presence of large amounts of non-insulin protein material, the movement of insulin is almost completely inhibited, even on the thicker Whatman papers; a development time of two days is necessary for even slight separation under these conditions. This difficulty could be obviated by using Munktell No. 20 electrophoresis paper, which permitted the insulin to move at its normal R_F, even when the paper was heavily loaded with crude material. In a large-scale experiment, 80 gm. of calf pancreas slices was incubated for 1·5 hr. in the presence of DL-leucine-1-^{14}C. After incubation, the pancreas slices and medium were lyophilized, extracted with acid-alcohol solution[1], the *p*H was adjusted to 6, and the proteins were precipitated with 2 volumes of ethanol and 4 volumes of ether. The precipitate was taken up in 0·05 *N* hydrochloric acid, and the soluble portion was dialysed against distilled water, concentrated, and streaked on to the paper. After elution of the insulin band with 0·01 *N* hydrochloric acid, the insulin was rechromatographed using the same system. A trace of protein remains at the origin. The yield of insulin after elution was 32 mgm. Evidence that the isolated insulin is pure, that it retains its biological potency, and that the labelled leucine is actually incorporated into the insulin molecule will be presented elsewhere[7].

This investigation was supported in part by a research grant (*A*-428) from the National Institute of Arthritis and Metabolic Diseases of the National Institutes of Health, Public Health Service, and in part by an institutional research grant from the American Cancer Society. We acknowledge with thanks the technical assistance of Miss Barbara Silver in various phases of this work.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A Photographic Method for the Study of Insect Migration

THE study of the migration of swarms of the desert locust (*Schistocerca gregaria* Forsk.) has involved the detailed analysis of the flight behaviour of the individual locusts constituting a swarm. Following Gunn *et al.*[1], it has been shown that by placing a camera on the ground with the lens pointing upwards, it is possible to obtain photographs of locusts flying in a swarm which are 'readable' up to the limits set by the lens, the shutter-speed in relation to the ground-speed of the locust, and the emulsion used. These photographs have been useful for determining the orientation of individuals and also, from the size of the images and of a sample of the locusts under observation, the area-density and volume-density of the flying locusts in the layer of the swarm resolvable by the camera.

A further development of this technique, using a camera modified to give two images of each locust on each negative separated by a known interval of time, has made it possible to record also the track and ground-speed of the individual locusts. By including in the field of view of the lens a wind vane, and also recording the corresponding wind-speed, the air-speed of the flying locusts can be estimated. An *F*.24 aerial survey camera was used, with a focal-plane shutter and a control unit (type 35) which can be set to give exposures automatically at any time interval between 3 and 50 sec. on a 100-exposure film in an interchangeable magazine. A modified shutter-blind was made with two $\frac{1}{4}$-in. slits instead of one, at a distance of $1\frac{1}{4}$ in. from each other, giving at the appropriate tension the sequence 1/500 sec. exposure – 1/50 sec. interval — 1/500 sec. exposure. The interval of 1/50 sec. between exposures gave locust images usually separated clearly but not by too great a distance for the pairing of corresponding images. An electric counter of post-office type, recording the revolutions of an electric anemometer, was fitted to the camera in place of the usual clock recording system. With the automatic control taking photographs at known time-intervals, each photograph thus recorded the speed and direction of the wind as well as the course and track of each locust, for which both ground-speed and air-speed could be estimated. The material is still in course of analysis; it has been found to provide evidence not only of the behaviour of the locusts but also of the fine structure of turbulent air.

I wish to thank Mr. L. Jackson, of the Williamson Manufacturing Co., Ltd., Willesden, for his co-operation in the manufacture of the shutters.

H. J. SAYER

Desert Locust Survey,
Nairobi, Kenya. Nov. 10.

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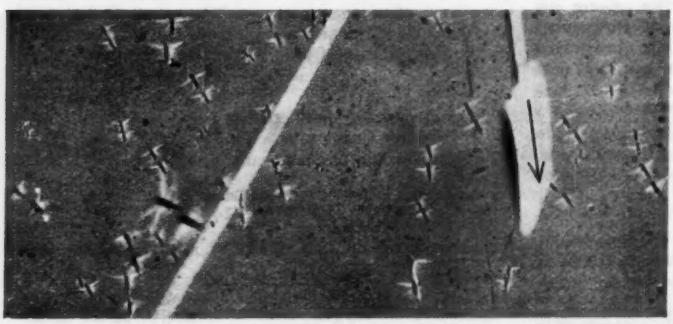

Fig. 1. Part of double-exposure vertical photograph of desert locusts, mainly flying up-wind; wind-direction indicated by arrow on wind-vane; Feb. 15, 1955, Mtito Andei, Kenya

Genetical Effects of Radiations from Products of Nuclear Explosions

PROF. J. B. S. HALDANE'S letter[1] on the genetical effects of radiation resulting from nuclear explosions raises the question of the relative dose-rates to man and to *Drosophila melanogaster* arising from natural sources of ionizing radiations. It appears to have been generally assumed that the background dose-rates to the gonads of all species are identical, whereas they are likely to differ considerably. The gonads of the *Drosophila*, for example, are exposed to both environmental β- and γ-rays, but those in most mammals are screened entirely from external β-rays and partly even from γ-rays. In Haldane's argument, deductions about radiation effects in *Drosophila* appear to have been carried over to the human case without allowing for this difference.

The suggestion that the radiation dose needed to double the human mutation-rate is a little more than 3 r. per generation is based by Haldane on the following arguments, set out in his Croonian Lecture[2]:

(1) ". . . it follows that human mutation rates are about twice those of Drosophila per nuclear division and about one two-hundredth of those of Drosophila per day."

(2) "It has been calculated that natural radiations and particles of high energy will account for only 0·001 of the mutations in Drosophila".

(3) "It is clear that if so they may account for about a fifth of those in man, and in view of the uncertainty of our knowledge as to the efficiency of particles from K40 and cosmic rays in producing mutations, and the different radiosensitivity of different genes, it is quite possible that radiation may account for most human mutation."

No reference is given for statement (2), but the result quoted is that given by Lea[3], where the fraction 0·001 is deduced on the basis of the known number of mutations produced per unit dose in *Drosophila* and an estimated background dose-rate of 50 ionizations per c.c. per sec., or 2·2 mr. per day, giving 0·05 r. in the life-span of the fly. This dose-rate, given by Lea[3] as a "generous estimate" based on the measurement of the natural leak of ionization chambers, must by its magnitude include ionization due to external β-radiation. By comparison, the background dose-rate which affects human soft tissues, including the gonads, is about 0·26 mr. per day[4], amounting to the value usually quoted of 3 r. in thirty years. This is only one-eighth of the dose-rate used

in the calculations on which the fraction of 0·001 in statement (2) is based and, if allowance for this is made in the argument of statement (3), the background radiation could account only for some 2·5 per cent of the human mutation-rate. Moreover, with regard to the role of potassium-40, the estimated dose-rate for man includes the radiation from the tissue content of potassium, the β-particles of which have approximately the same relative biological efficiency as γ-rays[5]. The proportion of the mutation-rate thus attributed to background radiation, namely, 2·5 per cent, is so much less than the figure of 20 per cent derived by Haldane in statement (3) that considerations other than the purely physical must be adduced if his contention that natural radiation accounts for most human mutation is to be supported.

It can be shown that, in this estimation of the fraction of the human mutation attributable to background radiation, the result depends only on the radiation-induced rate for *Drosophila* and the gonad dose to man. The dose-rate assumed for *Drosophila* determines the radiation fraction for that insect but does not affect the fraction estimated for humans. The argument in statement (3), based on the fraction for *Drosophila*, is only valid if the two species receive the same dose-rate.

In applying Russell's data[6] on radiation-induced mutations in mice to estimate the part played by radiation in human mutation, Muller[7] has also translated to the human case an estimated *Drosophila* background dose-rate of 0·045 r. in four weeks, getting, without further qualification, a gonad dose of 17·5 r. in thirty years. This figure is six times that usually taken as representative of areas of the world when the ground radioactivity is not exceptionally high, and is about four times the value which can be deduced from Sievert's results[8] for persons living in the average type of house in Stockholm, a region of admittedly high local radioactivity. Use of a generation-dose of 3 r. in Muller's calculation, however, leads to the conclusion that, in ordinary circumstances, about 4 per cent of the mutation-rate in man could be attributed to background radiation.

In the present lack of more detailed information, it might reasonably be taken that the gonad dose in man is due principally to cosmic rays, local γ-radiation and radiation arising from tissue potassium. The screening factor of tissues overlying the human gonads has not so far been determined, but, for local γ-radiation, it is probably about 2 when averaged for the male and female of the species. In *Drosophila melanogaster*, or other small insects, the dose from external β-radiation and perhaps also a contribution from α-radiation must be added to the γ-ray dose. Tissue potassium, however, will contribute little to the total because the β-particles of potassium-40, having mean ranges of 2 mm. in tissue, can leave only a negligible fraction of their energy in the organs of small dimensions in which they arise.

It is likely that more precise data will become available on the background dose-rates to man and to animal species used in genetical studies. Until then the above considerations would appear to be relevant to the assessment of the part played by background radiation in human genetics.

Note added in proof. Muller (*Bull. Atomic Scientists*, 11, No. 9, Nov. 1955; see *Nature*, Jan. 21, p. 103) has recalculated the fraction of the human mutation-rate attributable to natural radiation as lying between 8 and 16 per cent, on the basis of a gonad dose of 6 r. in 25–30 years. This gonad dose appears to be higher than measurements have so far indicated for regions outside known radioactive areas and is twice the value taken as representative for Britain.

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I must thank Prof. F. W. Spiers for pointing out some of the errors in the basis on which I suggested in 1948 that most human mutations might be due to the action of photons or particles of high energy. Perhaps, however, he was not quite accurate in writing of my "contention that natural radiation accounts for most human mutation". I stated that this was "quite possible", and still hold that opinion. Further, his estimate of the dose received by *Drosophila* may be a little low, since the larvæ spend their life embedded in a medium containing appreciable amounts of potassium. Wright[1], in rough agreement with Spiers, has suggested that about 0·00015 of mutations in *Drosophila melanogaster* are due to radiation and rapid particles. Thus my provisional figure of 20 per cent should probably be reduced to about 2·5 per cent. But Russell[2] finds a mean mutation-rate at seven mouse loci of $2{\cdot}5 \times 10^{-7}$ per roentgen, which is about fifteen times the rate in *Drosophila*. This suggests that 30–40 per cent of human mutations might be due to high-energy events. Since these estimates are extremely uncertain, I still do not think it impossible, or even very improbable, that most human mutations may be so caused. This hypothesis gives an upper limit to the possible harmful effect of induced radioactivity. Even if, as I hope, this limit is too high by a factor of ten or even a hundred, it seems worth stating, if only because, while suggesting a more serious situation than some physicists have calculated, it decisively negates prophecies of wholesale racial degeneration resulting from experimental atomic explosions.

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Imprinting in Animal Behaviour

A recent symposium on imprinting[1] focuses attention on a very important aspect of animal behaviour. Although Thorpe[2] and Verplank[3] have emphasized that imprinting should be considered in relation to other types of learning, one aspect which does not appear to have received much consideration is the question of the relevance of imprinting to ideas on the evolution of learning and of instinctive behaviour.

I would first like to direct attention to an anatomical parallel which may be helpful. In *Drosophila*, heat-shock at an appropriate stage results in the development of the cross-veinless phenotype.

Waddington[4] has shown that selection of those individuals which give the maximal response to the environmental heat stimulus builds up a genotype the reaction norm of which is gradually altered so that cross-veinlessness becomes more and more readily developed. Finally, a stage is reached where the environmental stimulus is no longer necessary, and the animals show the cross-veinless character without the necessity for heat treatment.

In the evolution of a fully innate behaviour pattern evoked by a releaser, it seems possible that a similar process may have occurred. It is difficult to imagine that the process could begin otherwise than with the making of an appropriate response, probably imperfectly performed and subject to trial and error, and with learning of a simple conditioning type involved in the determination of the situation in which the response is made. From this stage there will be rapid selection, on one hand for more perfect performance of the motor response, and on the other for the shortening of the conditioning period, provided the environmental stimulus (or some special part of the total stimulus situation) remains constant. As in the case of cross-veinless, this should result in the building up of a genotype giving the motor response in more and more perfect form with the learning period more and more curtailed. The final result will be the innate pattern evoked by its releaser. But may not imprinting represent a penultimate stage on this route, a stage in which the motor response has been perfected and the learning period has become vestigial but has not yet disappeared?

If this interpretation is valid, then some curious facts receive a possible explanation. Thorpe[5] has pointed out that in birds the characteristic song of the species is sometimes innate, sometimes imprinted and sometimes fully learnt. Even closely related species may differ in this character in a manner which is at first sight puzzling. If, however, these actually represent stages in the evolution of the innate pattern which has not yet been fully attained in all species, then the situation is comprehensible.

This, however, cannot be the whole story. If we refer again to anatomical parallels, we see that in many cases an adaptive 'developmental response' is innate—the classical case is the callosities of the ostrich; but in other cases the adaptive response remains a response to a necessary environmental stimulus—muscle hypertrophy with use and skin cornification in response to rubbing are the classical examples. In these latter cases it is easy to appreciate that the adaptive response to the stimulus is a more efficient device than a fully innate response would be. Full cornification of all skin areas potentially liable to rubbing might save the minor discomfort of a few blisters, but would detract greatly from tactile sensitivity and ability to do fine work; and maximal development of all muscles at all times would be physiologically wasteful. It is therefore relevant to ask, in the case of imprinting, whether in some cases there may not be a selective reason for the retention of the vestigial learning period, that is, whether the imprinting situation may not be more advantageous than a fully innate response would be. I believe that this is true in 'olfactory conditioning' of insects to their animal or plant hosts, of the type described by Thorpe[6] in the case of *Nemeritis*. Here, so long as recognition of the host is imprinted, no genetical change in its chemical constitution will rid it of its insect parasite or predator. Imprinting automatically keeps pace with any such change, whereas in the case of an innate response to a specific chemical stimulus, any mutation giving rise to a changed odour would render the host immune to attack.

There are other cases in which there also appear to be reasons for the imprinting period being retained. Verplank[3] suggests that in species showing parental care imprinting should occur most frequently in those the young of which are active very shortly after birth or hatching. This, I believe, may be a sort of evolutionary concession to the imperfectly developed sensory faculties of the newly born or hatched young. Since they are active and must be protected, a following response is necessary; but if their sensory faculties are as yet defective and the parent is at first little more than a moving object, then, perforce, the response must be to 'moving object'. At the same time, recognition of the parent must develop as rapidly as possible; and the most effective solution is what is actually found—an innate following response to any moving object, followed by fairly rapid imprinting. If this is correct, then we should find not only the correlation of imprinting with early locomotion suggested by Verplank, but also that speed of imprinting should be correlated with the development of sensory discriminatory abilities.

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Environmental Factors influencing Gonadotrophin Assay in the Rat

It has hitherto been assumed that environmental factors play their part in establishing the final characteristics of a population predominantly as modifiers of development[1,2]. This is clearly so when the end-products of cellular activity, as expressed in relatively stable anatomical structures, are under examination. When, however, attention is directed to the potentialities of an organ or tissue by measuring the rate of cellular activity, as in the response of tissues to the action of drugs, the environment can be expected to play a more immediate part.

Studies of the influence of factors in the environment of the immature female rat receiving serum gonadotrophin have revealed that they take a major part in determining not only the sensitivity of the ovarian-weight response, but more especially the variability within the group.

The following is a description of the test and a tabulation of representative results: Two days following weaning at 21–26 days old, each immature female rat is injected subcutaneously with 50 international units of 'Antostab' serum gonadotrophin in 0·2 ml. of distilled water. A similar injection is given on the three subsequent days in the morning, making a total of 200 international units in four days. The rats are killed on the fifth day and the ovaries dissected and weighed (mgm.) fresh after blotting on filter paper. All the injections are made immediately after the operator's hands have been washed, as the presence of smells from fæces or disinfectant on the hand was found to depress the response.

EFFECT OF CHANGES IN CAGE CONDITIONS

Cage	12/group Litter mates together Mean (mgm.)	4/cage Litter mates together Coefficient of variation (per cent)
Unchanged	122	13·4
Daily change	87	18·9
Litter mates distributed over treatments		
Unchanged	117	6·6
Daily change	80	14·0

EFFECT OF NON-RECURRENT CHANGES IN THE SOCIAL ENVIRONMENT
(In this test the animals were redistributed each day in such a way that they did not encounter any of their litter mates during the rest of the test. Since this test involved a new cage for each rat that was placed with new cage mates, the cages of all the groups were changed each day)

No. of changes	16/group Litter mates together at start Mean (mgm.)	4/cage Litter mates together at start Coefficient of variation (per cent)
0	99	8·3
4	111	17·9

EFFECT OF THE NUMBER OF RATS PER CAGE
(The size of cage was doubled for six and eight rats per cage in order to keep the area per rat roughly constant.)

No. in cage and date of test	Mean (mgm.)	No. in group	Coefficient of variation (per cent)
1	80	12	24·3
2 (25.2.55)	114	12	4·8
4	111	12	7·3
6 (13.5.55)	96	12	18·0
8 (18.5.55)	87	16	15·2
Repeat test			
1	160	12	30·6
2 (8.6.55)	212	12	5·7
4	231	12	8·5

Note that the response in the second test was nearly twice that in the first. This change in sensitivity is occasionally encountered and is usually termed 'seasonal variation'. On this occasion, however, the increased sensitivity lasted only a matter of a few weeks

EFFECT OF SIZE OF CAGE

	8/group Mean (mgm.)	2/cage Coefficient of variation (per cent)
Large	135	12·1
Medium	151	6·4
Small	157	28·6
	8/group	**8/cage**
Large	145	8·9
Medium	159	8·9

The medium cage is twice the size of the small cage and the large cage is twice that of the medium. The dimensions of the small cage are 9 in. × 12 in. × 6 in. high.

The response of the rats to follicle-stimulating hormone was clearly modified by the environment in which the rat was placed during the test. It is thus necessary to consider the interaction between the genotype and the environment as taking place in two ways. On one hand, environmental influences will modify development and so bring about variability in responsiveness to drugs within a population. On the other, the environment will cause variation by differences in the responsiveness of different animals to the pattern of stimuli present during the period when the drug is acting. These two categories may well interact to some extent separately with the genetic background. Moreover, since the immediate effect of the environment on the action of drugs appears in large part to be a nervous response, the environmental contribution to variability arising out of influences affecting the behaviour of the animals may be more closely linked to the genetics of the nervous system than to other hereditary differences.

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Environmental Factors affecting Hairiness in Mosquito Larvæ

Rosen and Rozeboom[1] have described a wide range of variation in larval hairiness in the *Aedes scutellaris* group of mosquitoes in Polynesia, and have shown that hairiness is conditioned by some environmental factor common in, but not restricted to, tree-holes. A similar situation has now been discovered in the related *Aedes albopictus* in Singapore; here, larvæ from tree-holes frequently have many of the body hairs longer, stouter and with more branches than in the normal form (Fig. 1). A colony established from hairy larvæ produced only normal larvæ in the laboratory, and the hairiness is clearly produced by some environmental factor. Rearing experiments showed that larvæ raised in the contents of some, but not all, tree-holes became hairy; siblings from the same batch of eggs, reared in tap water plus yeast, or in grass infusion, were normal. The related *Aedes aegypti* also gave hairy larvæ when reared in the appropriate medium, but *Culex fatigans* larvæ were not affected.

Since larvæ mature in five days in grass infusion, but may require up to fifteen days in tree-hole contents, it seemed possible that length of the growth period might affect hairiness. This was tested by rearing at different levels of nutrition; but no such effect could be detected. Also to be considered are the microflora and fauna of the tree-hole water, mainly crustaceans, rotifers, fungi and bacteria. However, cultures produced by inoculation of boiled grass infusion, when tested, gave no increase in hairiness. The living organisms, then, do not appear to play any direct part.

Rosen and Rozeboom[1] offer evidence that hairiness is associated with the presence of organic debris in the water; when this was removed by filtration, normal larvæ resulted. This has been tested for *A. albopictus*. Larvæ were first reared in supernatant fluid from a tree-hole culture, renewed daily; these proved to be as hairy as those from the original culture. Larvæ were then reared in tree-hole water filtered twice through Whatman's No. 1 paper; also, for comparison, in a water suspension of the debris, and in the original water. The two latter cultures gave all hairy larvæ; but those from the filtrate were also hairy, though to a reduced degree—specimens ranged from typically hairy down to almost normal. Finally, water, known to produce hairiness, was passed through a Seitz filter under sterile conditions, and two cultures were set up; in one, air-borne bacteria, etc., were allowed to accumulate, and the

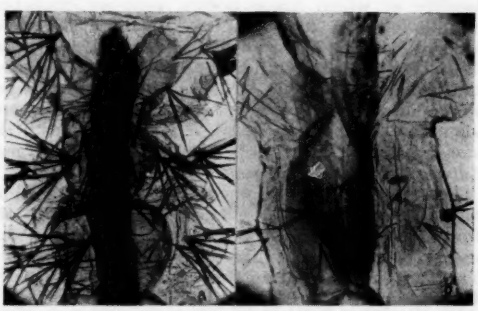

Fig. 1. *Aedes albopictus*, base of larval abdomen: (*a*) hairy larva; (*b*) normal larva

other was re-inoculated with bacterial film from the original culture. Both were almost colourless, as compared with the original deep brown colour, showing that much colloidal matter had been removed. Larvæ of *A. aegypti* were tested in these; growth was slow, and only a few reached maturity, but these showed no increase in hairiness when compared with controls.

These experiments, and those of Rosen and Rozeboom, suggest strongly that the factors producing hairiness reside in some non-living particle, commonly found in tree-hole water. In this case the particles appear to be much finer than was the case in Polynesia. In attempts to produce such particles in the laboratory, tests have been made of infusions of sawdust and suspensions of crude lignin, but none of these has caused any increase in hairiness of *A. albopictus* larvæ.

The nature of these particles is to be investigated further and the full results will be published in due course. Acknowledgments are due to Mr. Cheong Chee Hock for assistance with the photomicrographs, and to Dr. Lim Kok Ann for carrying out the filtration described above.

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Distribution of Physiological Races of *Phytophthora infestans* (Mont.) de Bary in Northern Ireland

Early reports on the distribution of physiological races of *Phytophthora infestans* (Mont.) de Bary showed that specialized races occurred only in districts where resistant potato seedlings were raised and grown[1–3]. Furthermore, it was considered that the unspecialized race, later designated race 0, was the only one to cause disease in commercial potato crops.

More recent work, however, has shown race 4 in Holland[4], and a mixture of race 0 and race 4 in Canada[5], to be the 'common race'.

A further contribution to our knowledge of the distribution of the physiological races of *P. infestans* may now be made from a survey carried out in Northern Ireland. Diseased potato foliage was collected from all parts of the country in 1954 with the view of ascertaining the identity of the most widespread race(s). A further collection from a locality at which many potato varieties, including many *Solanum tuberosum* × *Solanum demissum* hybrids, were being grown was also made in order to obtain as many different physiological races of the fungus as possible. The isolates of the fungus were cultured on pea-meal agar at 15–18° C. and identified by the detached leaf technique, using the variety British Queen and Black's set of single-gene differentials as the differential host series.

From seventeen commercial varieties (all *S. tuberosum* derivatives), seventy-three isolates of the fungus were obtained. Of these, seventy were identified as race 4 and the remaining three as race 0. These latter occurred on the varieties Arran Victory, Ulster Supreme and British Queen.

A total of nineteen isolates was obtained from the hybrid varieties. Of these, six remained unidentified due to lack of pathogenicity, and from the reactions of the remainder race 1, race 2, race 4, races 1, 2, races 1, 4, and races 1, 2, 4 were identified.

It is evident that at least seven physiological races of *P. infestans* are present in Northern Ireland but only one, race 4, has a widespread distribution.

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Rhizoctonia in Natural Grassland Soils

An investigation into various aspects of the microbiology of natural grassland soils is being carried out in these laboratories to serve as a guide in future studies on the microbiology of soils under introduced pasture grasses.

The native 'low tussock grasslands'[1] of New Zealand, with *Poa* and *Festuca* spp. dominant, cover approximately 7 million acres and occur mainly in the South Island. Areas are found from sea-level to 3,000 ft. and they provide extensive grazing for sheep. Three locations were chosen for sampling, one in the North Island on soil derived from volcanic ash (Waiouru) and two in the South Island, one on soil derived from sandstone (Bealey) and the other on soil derived from schist (Alexandra).

In a study of the mycology of these soils, the screened immersion-plate technique[2] and a plating method described by Warcup[3] were employed in parallel studies. Modified screens were employed in the former by constructing them with sides to form a shallow box. When assembled, the sides of the screens fitted closely over the sides of the boxes carrying the agar-coated plates in a manner similar to the fitting of Petri dish halves. 2 per cent distilled water agar was used, and the diameter of the screen apertures was reduced to $\frac{1}{8}$ in. Isolations were made from ten sites in each location in the spring, summer and autumn seasons of 1953–54. A total number of 1,669 specimens of mycelium were isolated by the screened immersion plates, and, of these, 831 specimens exhibited features of hyphal morphology similar to those shown by strains of the fungus *Rhizoctonia solani* Kuhn[4].

The predominance of *Rhizoctonia* mycelium as shown by screened plates was a constant feature in the three locations, the fungus occurring in both top and subsoil. In contrast, mycelium of *Rhizoctonia* was not recorded on any occasion with the plating method, although a number of other fungi were isolated. The failure to obtain *Rhizoctonia* by this method may be associated with the difficulty of maintaining transfer cultures on potato dextrose and malt agars.

In the extensive literature pertaining to soil mycology studies, there are few references to the occurrence of *Rhizoctonia* in isolations[5]. The majority of references concerning this much-studied fungus deal with pathogenic activity, and the direct isolation of the organism from sources other than infected material is seldom recorded.

The remarkable occurrence of *Rhizoctonia* in screened plate isolations in contrast to its absence in soil plates led to the application of other techniques to confirm the presence of *Rhizoctonia* mycelium in these tussock grassland soils.

Rossi–Cholodny[6] slides were prepared from the Waiouru soil and on microscopical examination showed widespread occurrence of *Rhizoctonia* mycelium. Examples of the previously recorded[7] hyphal contact association between actinomycetes and soil fungi, including *Rhizoctonia*, were also observed.

Agar-soil films devised by Jones and Mollison[8] were prepared from the soil at Waiouru, and hyphæ exhibiting characteristics associated with *Rhizoctonia* were recorded.

Finally, blocks of soil were brought to the laboratory and broken open along natural fracture lines by hand and directly examined with the aid of the incident-light equipment of a Leitz 'Ortholux' microscope. Mycelium with features associated with *Rhizoctonia* were observed frequently (see Fig. 1). By freehand manipulation with a sterile needle under incident light, portions of such mycelium were removed to normal microscope slides and identification confirmed.

Fig. 1. *Rhizoctonia* hyphæ in natural grassland soil. Photographed by incident light with 35-mm. 'Alpha' reflex camera and extension tube. (*a*) × 75; (*b*) × 125 approximately

The results have shown that the soil plating technique was unable to give a true indication of the fungus flora of these soils, as there was no evidence to show the presence of *Rhizoctonia* as active and widely occurring mycelium.

The abundant occurrence of one of the Mycelia Sterilia in screened immersion plates is claimed to be strong evidence that this technique isolates fungus specimens in the mycelial state from soil.

Results will be published in full at a later date.

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Aug. 12.

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Mycelial Aggregation of Sand Soil under *Pinus radiata*

The influence of soil micro-organisms upon the physical condition of soil has received some attention in recent years. Various workers[1] have shown that fungi and bacteria and their associated metabolic products are capable of affecting the structure of soils. Fungi act largely by the entangling effect of their hyphæ, and bacteria produce cementing and binding substances of a polysaccharide nature[2].

The present communication records the observation in the field of fungal mycelia occurring in quantity in soil, possibly associated with a measurable difference in structure.

During a survey of the sand soils of the Manawatu County, a difference was noted between Himatangi sand under manuka scrub (*Leptospermum* spp.) and this soil under *Pinus radiata*. Himatangi sand before afforestation was a weakly gleyed, yellow-brown sand, melanized by scrub, rushes and sedges. Under manuka the topsoil consists of seven inches of black, sandy soil with a weakly developed and very friable nutty structure (10–20 mm.). Under *P. radiata*, close to the bases of individual trees in a twenty-five year old plantation, the topsoil has a more fluffy appearance and a more strongly developed structure; individual aggregates, although friable, tend to cling together and some pressure is needed to separate them.

Within the soil under *P. radiata* trees there is a visible, very extensively ramifying network of fungal hyphæ, associated with tufts of yellowish mycelium. The hyphæ occur in great abundance and invest sand particles and aggregates to such an extent that a degree of physical cohesion is imparted (see Fig. 1).

Three samples of Himatangi sand under manuka and three under *P. radiata* were taken from nearby sites and several physical measurements were made (see Table 1).

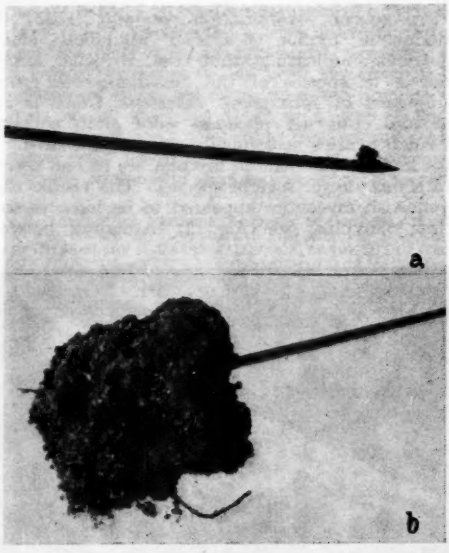

Fig. 1. Aggregation of sand soil by fungal hyphæ: (*a*) under *Leptospermum* spp., (*b*) under *P. radiata*. Approximately natural size

Table 1

	Under *P. radiata* Means and 95 per cent	Under *Leptospermum* spp. confidence levels
Total porosity (per cent)	58·2 ± 2·9	58·1 ± 4·1
'Large pores' (per cent)	24·9 ± 7·8*	12·3 ± 10·5

* Significant difference at the 5 per cent level.

Total porosity per cent is defined as :

$$\frac{\text{Volume of air in undisturbed sample}}{\text{Total volume of undisturbed sample}} \times \frac{100}{1}$$

The percentage of 'large pores' was measured by saturating undisturbed samples with water and then draining at a tension of 50 cm. water ; it is expressed as :

$$\frac{\text{Volume of pores drained}}{\text{Total volume of undisturbed sample}} \times \frac{100}{1}$$

No difference in stability of soil aggregates between the two sets of samples could be determined by standard wet-sieving methods, because the aggregates from both sites disintegrated with these techniques. However, when transferring saturated samples it was noted that a certain amount of the samples fell away. This manipulation was standardized and samples were weighed before and after handling, and the 'ability of aggregates to cohere' is expressed as :

$$\frac{\text{Weight of sample after handling}}{\text{Weight of original sample}} \times \frac{100}{1}$$

The large difference in variances between the two sites makes it impossible to compare these results by a t test. However, there appears to be a relatively greater cohesion in aggregates in samples taken from under *P. radiata* ; for example,

Under *P. radiata*	Under *Leptospermum* spp.
98·9	93·3
98·9	95·6
98·7	89·2

As the total porosity of the two soils is not significantly different, it is possible that the increase in 'large pores' per cent and the probable increased cohesion in soil under *P. radiata* could be attributed to the entanglement of soil particles by extensive fungal mycelia.

Microscopical examination showed that the predominant hyphæ possessed abundant clamp connexions, indicating that the mycelia largely belonged to species of the Basidiomycete group. Sporophores of *Rhizopogon rubescens*, *Clathrus cibarius* and *Geastrum plicatum* were often collected and small agarics occasionally seen on the area. It is not known whether the mycelia are of one species or of a mixture of several species. The visible tufts of yellowish mycelium appeared to be loose strands of many hyphæ (see Fig. 2) extending between

Fig. 2. Hyphæ forming a loose strand in sand soil under *P. radiata*. × 75 approximately

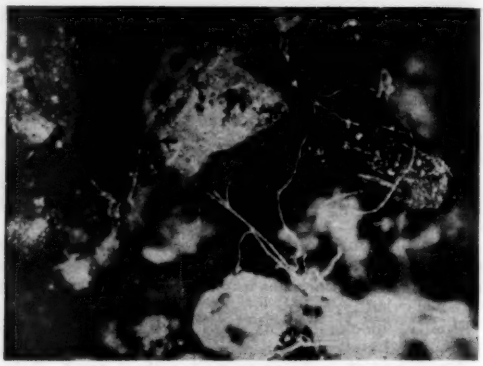

Fig. 3. Hyphæ investing sand grains in sand soil under *P. radiata*. × 160 approximately

decomposing plant fragments, whereas the more generally occurring hyphæ ramified extensively about sand particles and small aggregates (see Fig. 3) and particularly about decomposing fine root fragments. (Figs. 2 and 3 were photographed by incident light with a 35-mm. 'Alpha' reflex camera and extension tubes.)

Hyphæ were of four types : (*a*) yellowish, roughened-encrusted, septate hyphæ, 3–4 microns in diameter with clamp connexions ; (*b*) brown, very slightly roughened, septate hyphæ, 3–4 microns in diameter without clamp connexions ; (*c*) hyaline, roughened-encrusted, septate hyphæ, 2·0–2·5 microns in diameter with clamp connexions ; (*d*) yellowish, smooth, septate hyphæ, 3–4 microns in diameter with clamp connexions. Types (*a*) and (*b*) were associated with the strands of mycelium, whereas (*c*) and (*d*) occurred more generally within the soil.

The occurrence of Basidiomycete mycelia in such abundance in sand soil under *P. radiata*, sufficient, apparently, to produce a measurable difference in structure, appears worthy of record. Further observations are being carried out on this phenomenon and on grey 'bleached spots' occurring in this sand, which may be associated with the above condition.

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A Gigantic *Holoptychius* from Dura Den

The Upper Old Red Sandstone deposits of Dura Den in Fife are world-famous as a source of fossil fish, among which the dominant genus is the crossopterygian *Holoptychius*. Extensive collections are extant from excavations sponsored by the British Association in 1913 and from the work of earlier investigators.

A new fossiliferous stratum, some 35 ft. above the classical horizon, was found at Dura Den in 1954. From this there has just been recovered the central region of a *Holoptychius flemingi* very much larger

than any individual yet recorded. Measurements suggest a fish from eight to nine feet in length and a foot in girth. The remarkable size of this specimen merits a mention of the discovery.

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A Biological Factor inhibiting the Effect of Cortisone on Antibody Formation

PREVIOUS investigations in the adult white rat[1] have shown that intramuscular administration of cortisone can depress the hæmolysin response after a single intraperitoneal injection of sheep erythrocytes. The effect of cortisone is dependent on (1) the dose of antigen, (2) the dose of hormone, and (3) the time of administration of hormone (location in time in relation to the antigen injection). At the respective dose-levels (per 100 gm. weight) of 4 mgm. a day of cortisone and 2 ml. of a 0·03–0·3 per cent suspension of sheep erythrocytes the following time limits were found: a maximum effect was obtained when cortisone was given for three days, beginning two days before the antigen injection and ending with an injection on the day of antigen injection. The lack of significant effect of hormone injections after the day of antigen injection indicates that an early phase of the production of antibody is disturbed by the action of cortisone.

Of considerable interest in this connexion are investigations on the effect of total body irradiation on antibody formation (see footnote 2 for references). Several reports have indicated that a short initial period of the antibody production process is especially sensitive to damage produced by exposure to X-rays. There is thus a striking temporal similarity between the effects of cortisone and X-rays on antibody metabolism.

Investigations by Jacobson and his associates[3] on rabbits and rats have demonstrated that the depressing effect of X-rays on antibody formation is largely abolished by lead shielding of the spleen during irradiation. In the following experiments it has been shown that spleen or thymus cells from intact donors have a similar protective effect on rats treated with cortisone.

The test effect was the primary hæmolysin response in the rat and the experimental conditions those outlined in the first paragraph. Cortisone was given for six days, beginning four days before the antigen injection. The animals were bled on the fifth and seventh day after the antigen injection. The hæmolysin titre of serum was determined by a conventional method (titration by double dilution steps, guinea pig complement, sheep cells, incubation at 37° C., centrifugation and reading against a scale). The cell suspensions were prepared as follows: spleens or thymus glands were taken from adult rats weighing 200 gm. and 300 gm. The organs were finely minced, passed through a metal screen and suspended in a mixture of saline (2 parts) and Tyrode solution (1 part). Larger fragments, connective tissue, etc., were eliminated by filtration through sterile gauze. The cells were spun down at 1,500 r.p.m. for 10 min. and then resuspended in saline–Tyrode. The volume of the suspension was adjusted to contain cells from half a spleen (or a corresponding amount of thymus) in 3 ml., which constituted the standard dose. This dose, which was injected intraperitoneally, contained between 3×10^8 and $7{\cdot}5 \times 10^8$ nucleated cells. Most of these cells appeared to be in a good condition when examined in a phase-contrast microscope.

Table 1. EFFECT OF INTRAPERITONEAL INJECTIONS (DURING 4 DAYS) OF HOMOLOGOUS SPLEEN CELLS FROM INTACT DONORS ON ANTIBODY RESPONSE IN RATS TREATED WITH CORTISONE
Immunization: single intraperitoneal injection of sheep erythrocytes (on day 0). Antibody: hæmolysins measured on the fifth day (day 0 + 5) after the antigen injection and expressed as negative logarithm of the titre

Group	Treatment	No. of rats	Hæmolysin titre: Mean ± ε (mean)	Hæmolysin titre: Difference ± ε (diff.)*	P
I	Suspending agent of hormone	5	3·44 ± 0·44†	2·30 ± 0·64	< 0·01
II	Susp. ag. horm. + spleen cells‡	5	4·38 ± 0·50†		
III	Cortisone + spleen cells‡	5	4·24 ± 0·40	3·10 ± 0·62	< 0·01
IV	Cortisone = controls	5	1·14 ± 0·47	—	

* Difference between the group mean and the mean of the control group (IV).
† Difference between the means of group II and I = 0·94 ± 0·57 ($P > 0{\cdot}1$).
‡ Spleen cells were given from day 0 until day + 3.

In the first experiment (Table 1) two injections of spleen cells were given daily for four days beginning 5 hr. after the antigen injection. Cortisone alone produced a significant reduction of the hæmolysin response. When spleen cells were administered to animals treated with hormone, the mean antibody titre was significantly enhanced and there was no depression of the antibody response. In other experiments (Table 2) it has been shown that the same result can be produced by only one injection of the same dose of spleen cells if it is given on the day of antigen injection (hitherto injected 2 hr. after the antigen). Thymus cells seem to have the same effect (Table 2). Injections of spleen cells on the first, second and third day after the day of antigen injection have not been significantly effective. As shown in Table 2, the administration of spleen cells one day (22 hr.) before the antigen injection did not protect antibody production against cortisone.

In two experiments it has been shown that disintegration of spleen cells (grinding in a homogenizer at high speed) destroys their protective effect on antibody formation. Subcutaneous administration of intact cells gave no demonstrable enhancement of antibody response in animals treated with hormone.

Table 2. EFFECT ON ANTIBODY RESPONSE IN CORTISONE-TREATED RATS OF A SINGLE INTRAPERITONEAL INJECTION OF HOMOLOGOUS SPLEEN CELLS ON THE DAY BEFORE (DAY − 1) OR THE DAY OF (DAY 0) ANTIGEN INJECTION, OR (2) HOMOLOGOUS THYMUS CELLS ON DAY 0. Immunization and antibody determination as in Table 1, with the exception that hæmolysins were measured on day + 7.

Group	Treatment	No. of rats	Hæmolysin titre: Mean ± ε (mean)	Hæmolysin titre: Difference ± ε (diff.)*	P
I	None	9	1·89 ± 0·36	1·50 ± 0·41	< 0·01
II	Cortisone + spleen cells day − 1	8	0·35 ± 0·24	−0·04 ± 0·31	—
III	Cortisone + spleen cells day 0	7	3·43 ± 0·44	3·04 ± 0·45	< 0·001
IV	Cortisone + thymus cells day 0	9	2·03 ± 0·51	1·64 ± 0·55	< 0·01
V	Cortisone = controls	9	0·39 ± 0·20	—	

* Difference between the group mean and the mean of the control group (V).

The present results suggest that the spleen and thymus cells contain or, more probably, produce a factor, or have a cellular function, essential for some initial, cortisone-sensitive phase of the antibody production process.

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Inhibition of Influenza Virus Hæmagglutination by a Brain Lipid Fraction

There exists a rather ill-defined group of complex lipids that could be subsumed under the name of 'mucolipids'. These substances, while possessing constituents commonly considered characteristic of the cerebrosides, share some properties with the mucoproteins. Thus, they are soluble in water and include amino-sugars and a nitrogen-containing acid which gives rise to a violet colour with Bial's reagent and to a colour reaction with *p*-dimethylaminobenzaldehyde without previous treatment with alkali. We shall here refer to the substance yielding a direct Ehrlich reaction as 'direct chromogen', since we are not in a position to decide whether we are dealing with sialic acid[1], which was first isolated from submaxillary gland mucin[2], or with neuraminic acid[3] found in a group of lipids later designated as gangliosides[4]; nor indeed whether these two compounds differ.

Lipids of this type appear to have been encountered frequently in the older literature; but two fractions have been investigated in some detail, namely, the gangliosides occurring in nervous and other tissues[4,5], and strandin, a high-molecular lipid complex from brain[6]. The latter, to be exact, is stated to contain less than 1·5 per cent of neuraminic acid; but there can be little doubt that, as we shall show below, by a procedure similar to one of the methods used in the isolation of strandin (the 'partition-dialysis method'[6]), a lipid fraction can be obtained that contains about 20 per cent of 'direct chromogen' (compare also Chatagnon and Chatagnon[7]).

We have found that the lipid material isolated from the grey matter of ox brain by partition-dialysis, though having much in common with the gangliosides, can be distinguished from the latter: it possesses, in contrast to the ganglioside preparations tested, a strong inhibiting action on the agglutination of chicken erythrocytes by influenza virus. The isolation of the inhibiting lipid preparation was carried out at low temperature. Portions of freshly obtained grey matter were treated with 10 parts (v/w) of chloroform–methanol (2 : 1, v/v) in a high-speed mincer for 2 min.; the filtrate was subjected to dialysis in large 'Cellophane' bags against frequent changes of a 30-fold volume of distilled water for three days; the aqueous portion of the dialysis residue was reduced to about 0·7 per cent of its initial volume by rapid evaporation *in vacuo* at 30°; the concentrated solution was, after repeated dialysis as before, clarified by centrifugation (2,100 *g*, 30 min.) and freed of water by evaporation in the frozen state in a vacuum.

A typical preparation (prep. *IL*-1) accounted for about 0·3 per cent of the starting material and had nitrogen 3·9 per cent, phosphorus 0·7 per cent and a low iodine value (about 17). It contained 23 per cent hexose, identified as galactose, 4·5 per cent amino-sugar, identified as chondrosamine, and 20 per cent 'direct chromogen'. The absorption spectra resulting from the reaction of the chromogen with *p*-dimethylaminobenzaldehyde, diphenylamine, and Bial's reagent closely corresponded to those reported for sialic acid[8]. The study of other components is not yet completed; for example, a fatty-acid fraction and a number of amino-acids, of which several have been identified tentatively and which appear to constitute a polypeptide moiety yielding a weak biuret reaction and a single dinitrophenyl derivative.

Influenza virus (type *A*, *PR*8 strain), in the form of infective chorioallantoic fluid, was heated to 56° for 30 min. for use as 'indicator' virus in tests for inhibition of hæmagglutination. Under the conditions of assay, five hæmagglutinating units were regularly inhibited by a minimum of 10–20 μgm. of preparation *IL*-1, and in concurrent assays by a minimum of 2–5 μgm. of urinary mucoprotein[9].

For use in enzymic experiments, concentrated influenza virus (*PR*8) was prepared by centrifugation of fully infective chorioallantoic fluid (25,000 *g*, 1 hr.). The hæmagglutinating titre of the sedimented virus, taken up in a small volume of buffered saline (nine parts of 0·9 per cent sodium chloride, one part of 0·01 *M* phosphate buffer, *p*H 7·2) was twenty to thirty times that of the original chorioallantoic fluid. The lipid preparation, after incubation with concentrated active virus at 37° for 22 hr., lost completely its capacity to inhibit 'indicator' virus hæmagglutination, and 24·5 per cent of the 'direct chromogen' was split off in a dialysable form. Lipid treated with concentrated active virus at 4° for 22 hr., however, lost virtually none of its inhibitory potency, and no dialysable split products were found. Incubation with the receptor-destroying enzyme of *Vibrio cholerae* (30°, 24 hr.) also brought about complete inactivation and removed 39 per cent of the 'direct chromogen'. The power to inhibit virus hæmagglutination was also abolished by treatment with crystalline trypsin.

The success of further purification of the lipid material depended upon the procedures employed. When the separation by 'partition-dialysis'[6] was again applied to the isolated preparation, 64 per cent of the starting material was recovered as a fraction of undiminished inhibitory activity, containing 21 per cent of 'direct chromogen', and soluble in water, chloroform–methanol, moist benzene, and methanol. Procedures in which glacial acetic acid or pyridine were employed resulted in inactivation, though refluxing for 1 hr. in boiling chloroform–methanol or heating at 37° for 24 hr. in neutral aqueous solution did not affect the activity materially.

Two ganglioside preparations were also examined and proved completely inactive as inhibitors of hæmagglutination; they had been isolated, respectively, from the brain of a case of Tay-Sachs idiocy and from ox brain. The first-mentioned preparation also underwent 'partition-dialysis', as did the active lipid fraction *IL*-1 discussed before; it contained 32 per cent galactose, 5·4 per cent chondrosamine (as the hydrochloride), and 24 per cent of 'direct

chromogen'. No amino-acids could be found in paper chromatograms of an acid hydrolysate. The receptor-destroying enzyme of *V. cholerae* attacked this lipid to a slight degree, effecting the detachment of 7 per cent of the total chromogen.

The presence of the 'direct chromogen' clearly is not the only requisite for inhibiting activity[10]. One gains the impression that the lipids discussed here may belong to a series of substances of increasing complexity and molecular size, leading from the monomeric cerebrosides to the gangliosides and then to mucolipids in which the presence of a polypeptide moiety is necessary for the inhibitory activity to become noticeable.

This work, some aspects of which will form the subject of a detailed communication, has been supported by the Life Insurance Medical Research Fund and the Office of the Surgeon General, Department of the Army, Washington, D.C. One of us (A. R.) held a predoctoral research fellowship of the United States Public Health Service. We are grateful to Dr. R. H. Barnes, of Sharp and Dohme, Inc., for the receptor-destroying enzyme.

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Levels of Thyroid and Thyrotrophic Hormones in the Blood of Rats at Various Stages of the Œstrous Cycle

A comparison was made between the levels of thyroid and thyrotrophic hormones in the blood of female albino rats during the four stages of the œstrous cycle. The procedure used was that adopted by D'Angello and Gordon[1], namely, 'the stasis tadpole method'. Serum was obtained from the blood of the rats, which were divided into four groups of five or six each according to the vaginal smear reading. These groups were of pro-œstrous, œstrous, metœstrous and diœstrous rats. The tadpoles were divided into five groups, one of which was the untreated control. The others were injected with seven injections of 0·01 ml. of serum obtained from the four groups of rats on alternate days. Twenty-four hours after the last injection the tadpoles were killed with chloroform, fixed in susa and stored in 80 per cent alcohol. Their hindlimbs were then measured with a micrometer; this was used as a criterion of thyroid hormone activity. The height of the epithelial cells of the thyroids of tadpoles was used as an indication of the level of thyrotrophic hormone in the blood of the different groups of rats. The results are shown in Table 1.

Table 1. Thyroid and Thyrotrophic Hormone-Levels in the Blood of Rats at the Stages of the Œstrous Cycle

Phase of cycle	No. of tadpoles	Mean increase of hindlimb above control (mm.)	Mean increase of height of epithelial cells above control
Pro-œstrus	17	1·02 ± 0·12*	0·69 ± 0·14*
Œstrus	13	1·58† ± 0·11	1·89† ± 0·15
Metœstrus	15	1·07 ± 0·08	0·64 ± 0·07
Diœstrus	22	0·84 ± 0·06	0·66 ± 0·07

* Standard error. † Significantly higher than other groups.

It appears clearly that thyroid activity increases during the œstrus phase when compared with the other three stages of the cycle. The rate of metamorphosis of the tadpoles injected with the serum obtained from this group of rats was the greatest. The increase of hindlimb above the control was 1·58 ± 0·11 mm. The rate of metamorphosis was at its lowest in the tadpoles injected with the serum obtained from diœstrous rats.

The level of thyrotrophic hormone in the blood of these animals parallels closely the state of the thyroid. Thyrotrophic hormone was found to be produced at its highest level during œstrus. These findings agree with previous observations which indicated that the uptake of iodine-131 by rat thyroids is at its highest during œstrus[2], and that the level of thyrotrophic hormone in the rabbit is higher during œstrus than during pseudopregnancy[3].

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Amino-Acid Metabolism of *Nicotiana* Leaves after Removal from Plant

Vickery *et al.*[1] have shown that after removal from the plant, *Nicotiana* leaves show a marked increase in the total soluble nitrogen (ammonia, amide and amino-nitrogen) whereas the insoluble protein nitrogen decreases. An attempt has been made in the present work to study, in detail, the amino-acid metabolism in such leaves using the technique of horizontal migration paper chromatography[2].

The free amino-acids originally present in the leaves, at 0 hr., show interesting variations after plucking. Though the content of tyrosine (R_F 0·66) does not show any notable increase, alanine (R_F 0·59) and glutamic acid (R_F 0·52) increase up to 120 hr. in the dark, after which they show a marked decrease. In light alternated with twelve hours of darkness, alanine and glutamic acid go on increasing until 144 hr., after which they show a slight decrease at 168 hr. Proline (R_F 0·63) shows interesting variations under conditions of both light and dark. Proline starts disappearing from the detached leaves when the latter are kept in the dark and becomes untraceable at 144 hr.; but in light alternated with darkness, it persists even up to 168 hr. without decreasing.

The content of aspartic acid (R_F 0·47) shows marked variations with time after removal from plant. It increases considerably during the first 72 hr. in the dark, after which it starts decreasing,

reaching its minimum at 192 hr. It is important to note that in light (alternated with 12 hr. of darkness) the content of aspartic acid continues to increase, even up to 168 hr. The content of histidine–lysine (R_F 0·36) in the plucked leaf increases progressively in light and continuous dark even up to 168 hr. In the later stages, due to excessive formation of asparagine, the histidine–lysine band becomes superimposed by the thick asparagine band to form an asparagine–histidine–lysine complex. Asparagine (R_F 0·37) makes its appearance in the free state at 48 hr. after plucking and continues to accumulate up to at least 192 hr.

Apart from the changes in the various free amino-acids originally present in the leaves, other amino-acids also appear. Phenylalanine (R_F 0·83), and valine and methionine (R_F 0·76), which cannot be traced at 0 hr., make their appearance only 48 hr. after plucking and in the dark. They increase up to 120 hr., when they show the maximum depth of the bands. At 144 hr. and onwards valine–methionine is absent, but phenylalanine persists up to 192 hr. In light alternated with twelve hours of darkness, at 48 hr. after plucking, only valine and methionine appear, while phenylalanine appears only at 72 hr. Their content then increases up to 144 hr. in light, after which they are slightly reduced. It is to be noted that valine–methionine is not altogether lost even up to 168 hr. after plucking the leaves and in the light.

Multiple development of the chromatograms has shown that in light (alternated with 12 hr. of darkness), a new band, of R_F 0·51 lower than aspartic acid and higher than asparagine, is formed just after 48 hr. after plucking and goes on increasing up to 168 hr. This band is absent in the leaves kept in the dark. Multiple development of the chromatogram separates the lower bands, but it results in the formation of a phenylalanine–valine–methionine complex at the top as a thick broad band.

The possibility exists that the new range of free amino-acids are formed as a result of hydrolysis of insoluble leaf protein. The decrease with time in the amount of free amino-acids in leaves after removal from the plant suggests these are probably being used up in respiration. The persistence of proline in the light and the appearance of the new band suggest that some light-reacting systems are also involved in the metabolism of plucked *Nicotiana* leaves.

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Nuclear and Cytoplasmic Volumes in the Hepatic Cells of the Fœtal Sheep

In an investigation of the development of the individual hepatic cell in the fœtal sheep, a new method was used to measure the volume of the nucleus and cytoplasm at different stages of development.

Material was fixed in Rossman's fluid (9 parts of a saturated alcoholic solution of picric acid to 1 part of 10 per cent neutral formalin), embedded in paraffin, sectioned at 5μ, and stained with hæmatoxylin and eosin. Measurements of the apparent length and breadth of twenty nuclei were made on each section. Nuclei were chosen at random, but measurements were made only on those the greatest diameters of which lay within the section as seen by focusing up and down. From these measurements the nuclear volume was calculated, making the assumption that the nucleus was in the form of a prolate spheroid with greatest diameter in the plane of the section and not at right angles to it. This method may involve a slight under-estimate of the nuclear volume in rare cases (in fact the greatest diameter usually lies in the plane of the section at right angles to the direction of 'section compression'), but it is unlikely to affect significantly the averages for each section. The mean nucleo-cytoplasmic ratio was then measured by the method of Chalkley[1]. Four series of observations each containing twenty-five 'hits' on nuclei were made for each liver, the average of the four values of the ratio so obtained was taken and the standard error of the mean used as an index of the error of the estimate. From the values of nuclear volume and nucleo-cytoplasmic ratio thus obtained, the cytoplasmic volume and the total cell volume were calculated.

The results of the measurements so far made are shown in Table 1. Although they provide no statistically significant evidence of change in the nuclear, cytoplasmic or total cell volumes between the 29-mm. stage and term, there is a suggestion that the nuclear volume may diminish slightly and the cytoplasmic volume increase; and this is supported by the fact that there is a statistically significant increase in the nucleo-cytoplasmic ratio over the same period. The positive regression coefficient is significantly different from zero ($0{\cdot}05 > P > 0{\cdot}025$). The results for the 22-mm. and 26-mm. fœtuses further suggest that prior to the 29-mm. stage the cytoplasmic volume and thus the nucleo-cytoplasmic ratio are increasing rapidly.

This apparent turning point at the 29-mm. stage may be correlated with the fact that histochemical investigation shows that glycogen first appears in the sheep fœtal liver at that time. As demonstrated in the chick[2], the appearance of glycogen coincides with "the loss of enzymatic activity necessary for the respiratory catabolism of glucose" and thus marks an important step in the development of the hepatic cell. It may well therefore be associated with a

Table 1

Serial No.	Fore-head–rump length (mm.)	Mean nuclear volume (cu.μ)	Mean cyto-plasmic volume (cu.μ)	Mean total cell volume (cu.μ)	Mean nucleo-cytoplasmic ratio
1	22	127±9	368±36	495±49	2·91±0·20
2	26	135±6	514±39	649±49	3·79±0·23
3	29	150±9	652±45	802±55	4·34±0·17
4	38	171±8	756±68	927±83	4·43±0·35
5	54	130±6	684±39	814±46	5·25±0·17
6	56	149±7	894±55	1,043±65	6·01±0·22
7	61	156±8	824±82	980±97	5·27±0·44
8	106	142±6	716±62	858±74	5·05±0·38
9	116	166±8	818±84	984±101	4·94±0·46
10	131	114±8	541±46	655±56	4·74±0·21
11	230	137±6	679±47	816±56	4·96±0·26
12	265	155±8	707±37	862±45	4·57±0·08
13	290	147±6	741±84	888±100	5·56±0·58
14	345	159±6	998±80	1,157±93	6·29±0·48
15	375	127±8	675±56	802±67	5·30±0·27
16	380	168±8	1,158±80	1,326±91	6·88±0·33
17	440	126±6	644±59	770±71	5·09±0·41
18	450	112±3	675±48	787±56	6·05±0·40

The index of variation used is the standard error of the mean.

retardation in the rate of growth of the hepatic cell cytoplasm.

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Synthesis of Long-Chain Fats by Bacteria isolated from Human Fæces

We have recently isolated an organism from the stool of an adult human subject that is capable of synthesizing significant quantities of fatty material, which become visible on the surface, from a fat-free medium. The fat is neutral in character, liberating fatty acids on hydrolysis, and can be removed from the surface by dissolving it in ether. It is colourless and melts below body temperature. Some of its properties are shown in Table 1. Relatively little fat is present in the medium and organisms, and has not so far been investigated.

Table 1

Saponification value	190	Reichert value	42·1
Acid equivalent	294	Free fatty acids (as oleic)	0·27 per cent
Iodine value	49·5	Phospholipid (as lecithin)	0·7 per cent

The fat was prepared by inoculating a fat-free glucose peptone medium and allowing the fat to accumulate on the surface. The organisms were Gram-positive, and were observed in short chains and pairs. The organisms do not retain sudan black, but the fat produced in the medium stains readily with 50 per cent sudan black or sudan IV. (The organisms appear to resemble *Streptococcus faecalis*.) The growth of bacteria and the synthesis of fat are stimulated by the presence of folic acid as shown in Fig. 1.

These organisms were obtained from a patient with steatorrhœa under treatment with folic acid, and from the amounts obtained under these *in vitro* conditions, namely, 200 mgm. in four days in 10 ml. of medium, it would appear that fat synthesis of this type might make a significant contribution to fæcal fat. This possibility is being studied in other patients, and at the same time the properties of the fat and the factors affecting the quantity of fat formed are being more fully investigated.

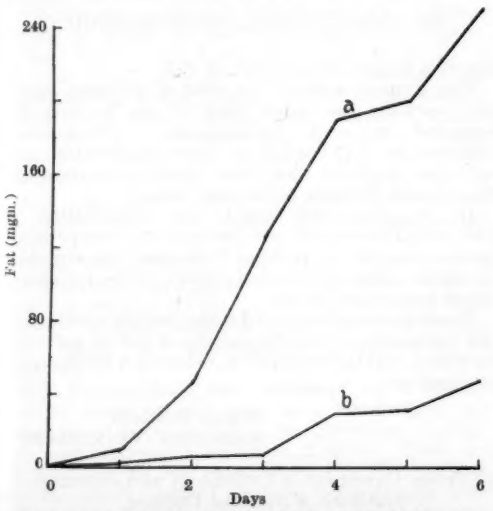

Fig. 1. 10 ml. glucose/peptone in each tube. (*a*) With folic acid; (*b*) without folic acid

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Amino-Acid Patterns of Urine and Blood Plasma in a Cystinuric Labrador Dog

It was shown by Lassaigne more than 130 years ago that cystine calculi may occur in the urinary tract of dogs. Canine cystinuria has since been recognized widely. Thus, more recently, 3 per cent of urinary calculi removed surgically from dogs in Holland and in Denmark[1] were composed of cystine, and 18 per cent in England[2], where White found them to be the commonest type (55 per cent of cases) causing urethral impaction. Canine cystinuria, with or without calculus formation, is said to be common also in France. Cystine calculi have been recorded from many breeds of dogs[2–4], but not hitherto from the Labrador. Furthermore, no study of the amino-acid patterns of the urine and plasma has previously been described; and hence it was not known if canine cystinuria is etiologically analogous with human cystinuria. If it were so, the usefulness of the cystinuric dog as a model for investigation of the human condition would be enhanced.

The subject of this communication is a male Labrador which first developed acute urinary retention in June 1951 when seven years old. Numerous small vesical calculi, and some impacted in the urethra near the penile bone, were removed surgically. A similar attack followed in November 1952, and also required urgent surgery. The animal was then placed on a reduced protein diet, and daily potassium citrate to alkalinize the urine; but, in spite of this, another crisis requiring surgical intervention occurred in October 1954.

Dent and Rose[5], in a study of fifteen cases of human cystinuria by means of two-dimensional paper chromatography, found that excessive urinary excretion of lysine invariably accompanied cystine, and that abnormal excretions of arginine and ornithine varied. The opportunity was therefore taken, after the second attack in this dog, of determining whether or not the amino-acid patterns in the urine and the plasma differed from those in human cystinuria.

One specimen of urine was obtained from the dog in November 1954, and a second specimen five weeks later. A sample of plasma was obtained with the second specimen of urine. Both specimens of urine gave strongly positive reactions for cystine with the sodium cyanide/nitroprusside test, and the typical cystine crystals were observed in the deposits after centrifuging.

The plasma was deproteinized, and the resultant liquid and the two specimens of urine desalted, oxidized and chromatographed by methods outlined

by Dent[6]. 500 μl. of deproteinized and desalted plasma, and amounts of desalted urine corresponding to 250 μgm. of total nitrogen (Kjeldahl), were spotted on to 60-cm. squares of Whatman No. 4 paper, and were run in phenol saturated with water, followed by collidine–lutidine. The final positions of the amino-acids were revealed by spraying with a solution of 0·1 per cent ninhydrin in butanol, and examining after 24 hr. at room temperature.

Unidimensional chromatograms on Whatman No. 1 paper were run in butanol/acetic acid/water (4 : 1 : 5) using amounts of urine equivalent to 250 and 500 μgm. of nitrogen. No ornithine was detected after treatment with vanillin followed by alcoholic potash and heating. Histidine was detected in both specimens of urine by repeating the unidimensional runs in collidine–lutidine, and spraying with Pauly reagent.

In the first specimen of urine, cystine and lysine predominate, superimposed on a pattern consisting of glycine and taurine with traces of alanine, glutamine, serine, glutamic acid and methyl histidine. Traces of leucine and/or *iso*leucine and aspartic acid were obtained in the first specimen only, whereas threonine (confirmed by running with an authentic specimen) and β-alanine and/or citrulline were detected in both specimens of urine. Arginine was not detected in abnormal quantities.

In contrast to the affected dog, chromatography of a catheter specimen of urine obtained as a control from a healthy Labrador bitch nine months old revealed only a trace of cystine and no lysine. The amino-acid pattern consisted of glycine and taurine, with traces of alanine, glutamine, serine, methyl histidine and glutamic acid. The nitroprusside test for cystine was negative, and no cystine crystals were detected in the deposit after centrifuging the urine.

The amino-acid pattern of the plasma from the affected dog shows a small spot due to cystine (in contrast with the large spot found in the urine), supporting the view that we are dealing here, as in the human form of the disease, with a defect of tubular reabsorption of cystine from the glomerular ultrafiltrate. A similar mechanism would also account for the presence of lysine and threonine in the urine, since neither of these amino-acids was detected in the urine of the control animal.

The amino-acid pattern of the urine from this cystinuric dog is therefore, apart from threonine, identical with that found in cases of human cystinuria, while the finding of a low plasma-cystine points to a similar etiology.

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Formation of Calcium Superoxide

In connexion with an investigation on the formation and structure of certain alkaline-earth peroxides and superoxides, the dehydration of the compound $CaO_2.8H_2O$ has been studied. It has been proved that drying this hydrate with phosphorus pentoxide at room temperature will not yield pure CaO_2, but a substance with the following approximate composition: $Ca^{2+}(O_2^{2-})_{0.87}(O_2^{-})_{0.05}(O^{2-})_{0.11}(H_2O)_{0.19}$.

The presence of superoxide ion (O_2^-) has been established by means of both chemical methods and by measuring the magnetic susceptibility.

The composition of this substance indicates that the dehydration is associated with a disproportionation of the following kind:

$$O_2^{2-} = (1-y)\,O_2^{2-} + \tfrac{2}{3}y\,O_2^{-} + \tfrac{2}{3}y\,O^{2-}$$

where y represents the degree to which the peroxide ions (O_2^{2-}) have been disproportionated.

Since the substance is hydrous, it is probable that the oxide ion exists as a hydroxide ion. Warming the dehydration product leads to an increase in the y-value, which, in the temperature interval 100–250° C., approaches 0·5. Heating to higher temperatures will cause decomposition.

X-ray photographs of the preparations have been taken using the Guinier method. In all cases the photographs exhibit only one phase with tetragonal symmetry. The a-axis is constant, but the c-axis increases slightly with increasing y. The following values have been obtained: $a = 5{\cdot}03$ A.; $c = 5{\cdot}95$–$5{\cdot}97$ A.

Intensity calculations and density determinations indicate that the phase concerned has a variable composition. It can be described as a compound CaO_2 with a CaC_2-structure where some of the O_2^{2-}-ions (peroxide ions) in statistical distribution are substituted by O_2^--ions (superoxide ions), O^{2-}-ions, and OH^--ions. Some of the Ca^{2+}-ions are also substituted by O^{2-}-ions.

The results obtained thus indicate that the composition of the phase can be described by the formula:

$$6(1-y)CaO_2 \cdot 2yCa(O_2)_2 \cdot 2yCaO \cdot 2yCa(OH)_2$$

where y ranges from $\sim 0{\cdot}1$ to $0{\cdot}5$.

This formula seems to be valid in all cases, where any warming has taken place of the product dehydrated at room temperature. Preparations obtained by dehydration at room temperature only are more hydrous than those which correspond to the general formula mentioned above.

If, on the other hand, the dehydration of $CaO_2.8H_2O$ is carried out directly at a temperature greater than 40° C., a phase is obtained the structure of which seems to be a superlattice of the tetragonal phase mentioned above.

These investigations, which also include corresponding compounds with other cations as well as peroxide-hydrates, will be described in detail in a forthcoming publication.

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Homogeneous and Heterogeneous Graphitization of Carbon

It is well known that, on heating to temperatures between 1,700° and 3,000° C., some carbons show a continuous and homogeneous development of the three-dimensional structure of graphite, whereas in others the structure does not develop beyond the stage of small regions of 'turbostratic'[1] order. It has been shown[2] that graphitization is impeded when there is strong cross-linking between the small ordered regions (which are formed in all carbons at low temperatures), and also when there is random orientation between neighbouring ordered regions. Of these two factors, the latter is the more fundamental. At sufficiently high temperatures, cross-linking is always destroyed[2]; but, where random orientation exists, no homogeneous graphitization occurs.

In most non-graphitizing carbons, however, a small quantity of highly graphitic carbon is formed, as a separate phase, at some temperature above 2,000° C. This phenomenon has been interpreted in the following way[2]. When a carbon in which the ordered regions are strongly cross-linked in three dimensions is heated to high temperatures, great internal stresses develop; the system of cross-linking imposes a low overall thermal expansion, whereas the expansion coefficient of the ordered regions must be at least as great as that of graphite. This results in local breakdown of the cross-linking, followed by a corresponding local crystallization of the carbon under pressure, the process continuing until the internal stresses have been relieved to such an extent that no further breakdown of the cross-linking occurs.

Thus, we see that, although cross-linking prevents the homogeneous development of a graphitic structure, it promotes the heterogeneous formation of a small quantity of highly graphitic carbon in non-graphitizing carbons.

The above observations provide a possible explanation of some results obtained in an investigation of the influence of the oxidation of a coal on the graphitization of a coke prepared from it.

A coking coal which normally yielded graphitizing carbons was oxidized in air at 110° for periods up to twenty days. Samples withdrawn after different periods of oxidation were then heated at 2,700° C. It was found that short periods of oxidation of the coal (up to about five days) decreased the graphitization of the carbon. After longer periods, however, the graphitization again increased, but it now occurred heterogeneously instead of homogeneously; the X-ray diffraction patterns of the carbons showed clearly the presence of a mixture of highly graphitized and non-graphitized material (cf. ref. 2) rather than a single, partially graphitized phase[3].

These results suggest that mild oxidation of a coal leads to cross-linking which inhibits crystallite growth in the carbon, whereas in carbon formed from strongly oxidized coals the system of cross-linking is so strong that heterogeneous graphitization is promoted.

This interpretation was confirmed by a similar series of measurements made on a non-graphitizing coal oxidized in air at 110° C. for periods up to sixty days, and afterwards heated to 2,700° C. Both the raw coal and the coal oxidized for four days yielded carbons which showed neither homogeneous nor heterogeneous graphitization. A trace of heterogeneously formed graphitic carbon was first observed in the sample oxidized for fifteen days. Longer periods of oxidation resulted in the heterogeneous formation of larger quantities of graphitic carbon, the proportion reaching 9 per cent after sixty days of oxidation. Thus in this case, again, the strengthening of cross-linking brought about by oxidation increased the heterogeneous formation of graphitic carbon.

It therefore appears that graphitization can occur by two quite distinct processes. Homogeneous graphitization occurs in carbons in which neighbouring ordered regions lie in near-parallel orientation, and in which cross-linking is weak[2]. Heterogeneous graphitization results when cross-linking is so strong that, when it starts to break down at high temperatures, localized forced crystallization under pressure occurs.

Since heterogeneous graphitization involves the breakdown of cross-linking, it sets in at a higher temperature than homogeneous graphitization. The graphitic product, however, is more highly graphitized than a product of homogeneous graphitization at the same temperature, since it is crystallized under pressure.

The experiments described above were carried out during 1950 at the Laboratoire Central des Services Chimiques de l'État, 12 quai Henri IV, Paris. I am indebted to M. J. Méring for many helpful discussions.

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Sept. 7.

[1] Biscoe, J., and Warren, B. E., *J. App. Phys.*, **13**, 364 (1942).
[2] Franklin, R. E., *Proc. Roy. Soc.*, A, **209**, 196 (1951).
[3] Franklin, R. E., *Acta Cryst.*, **4**, 253 (1951).

Diffusion of Interlayer Water in Vermiculite

A convenient optical method for studying the diffusion of water molecules in vermiculite is outlined below. The effect has similarities to that employed by Tiselius[1] in his studies of diffusion in the zeolites; but, in this instance, it can be observed in reflected or transmitted light and is not a birefringence effect. Although magnesium vermiculite is referred to particularly, vermiculites saturated with cations other than magnesium behave in a similar (although not identical) manner.

When a flake of magnesium vermiculite, which has been partially dehydrated to the phase containing single sheets of interlayer water molecules (d_{001} = 11·59 A.), is allowed to become rehydrated, a dark line is observed to enter the flake at the edges and gradually converge on the centre. Inspection under the microscope reveals that the first moving boundary is followed by a second which is much fainter and travels at a slower rate (Fig. 1). These boundaries represent wave-fronts of water molecules diffusing into the crystal. The first and stronger of the two is caused by a phase change corresponding to an expansion of the lattice in the *c*-direction from 11·59 A. to 13·82 A., and the second by a smaller lattice expansion from 13·82 A. to 14·36 A.[2]. The reverse process, namely, dehydration, is rather more difficult to observe.

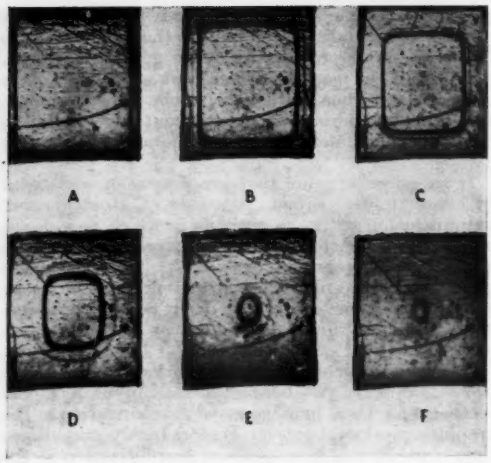

Fig. 1. Photographs taken at intervals during the diffusion of water molecules into a partially dehydrated magnesium vermiculite crystal

It is evident from Fig. 1 that the rate of diffusion in the plane of the layers for each phase-change is equal in all directions. Perpendicular to this plane the diffusion is effectively nil. Rate measurements indicate that the distance travelled is proportional to the square root of the time taken, in agreement with the requirements of the theory of diffusion. With a flake 2 mm. square, rehydration takes several minutes at 20° C. and 50 per cent relative humidity. The appearance of the crystal in section at an intermediate stage of the hydration process is shown diagrammatically in Fig. 2. Considerable distortion of the silicate layers must occur at the phase boundaries, especially where mutual displacements of the silicate layers are involved as in the 13·82 A.–14·36 A. transition. The elasticity of the silicate layers is evinced by the fact that the process may be repeated a number of times without appreciable diminution in the sharpness of the boundaries.

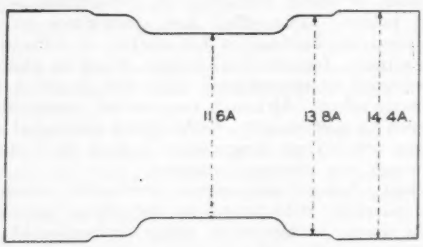

Fig. 2. Sectional diagram of a magnesium vermiculite crystal at an intermediate stage of rehydration (approximately to scale)

Under suitable conditions, the formation of organic complexes can also be followed by this method.

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[1] Tiselius, A., *J. Phys. Chem.*, **40**, 223 (1936).
[2] Walker, G. F., Proc. Fourth Nat. Clay Min. Conf., Penn. State Univ. (1955).

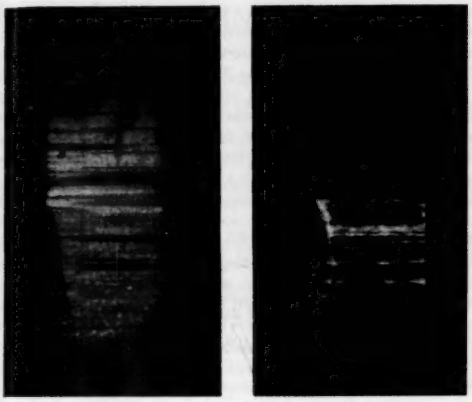
Electroluminescence in Disordered Zinc Sulphide

In recent times a detailed study has been made of the structure of zinc sulphide crystals[1], and of the solid-state properties, particularly electroluminescence[2], of this compound. Of the many factors which may influence the electrical and optical properties of zinc sulphide, little attention has so far been paid to the effect of the modifications which can occur in the crystal structure. In addition to the well-known cubic (sphalerite) and hexagonal (wurtzite) forms, single crystals of zinc sulphide can also be obtained with a one-dimensional stacking disorder of the hexagonal (0001) planes[3]. This disorder may exhibit a periodic arrangement resulting in the formation of polytypes[1]. Although no experimental work seems to have been published linking electroluminescence with disorder, Schneer[4] has, from theoretical considerations, suggested that there may be some connexion; in addition, the electroluminescent properties of some zinc sulphide phosphors have been tentatively ascribed to a partial transformation from hexagonal to cubic[5].

Experiments in these laboratories have led us to believe that electroluminescence both in single crystals and in powders may be associated, in some circumstances, with the phenomenon of one-dimensional disorder. Needle-shaped crystals of zinc sulphide, prepared by a sublimation technique and activated by thermal diffusion of copper from the crystal surface, were seen to exhibit parallel streaks of blue electroluminescence in a manner very similar to that described by Diemer[6]. Examination under the polarizing microscope, between crossed nicols, revealed bands of interference colours; from an X-ray examination these bands were found to be perpendicular to the *c*-axis of the crystal, and to originate from random one-dimensional stacking disorders. The electroluminescent streaks were observed to be strictly parallel to these colour bands; this is clearly demonstrated in the accompanying photographs. In Fig. 1*a* a crystal between crossed nicols is shown, the interference colours appearing, of course, as different shades of grey; Fig. 1*b* is the light pattern produced in the region between the electrodes by an alternating field of 10 kc./s. The streaks of light are clearly parallel to the coloured bands, although not all the bands have an associated electroluminescent streak. Observations of the blue electroluminescent streaks and colour bands, simultaneously, give a precise confirmation of this parallelism, but in a monochrome photograph they would be indistinguishable. The pattern remains unchanged regardless of the alteration of the field direction produced by change of electrode positions; the overall brightness, however, does alter and is a maximum when the field is in the same direction as the streaks and bands.

A second batch of crystals, subjected to an identical activation treatment, had a higher apparent brightness, and optical and X-ray examination suggest a more extensive disorder. These crystals displayed many more light sources, both in the form of streaks and points, than were apparent in the needle-type crystals described above. The streaks of electroluminescence were again in alignment with the colour bands.

In the case of powders, it was found that, in a particular series of zinc sulphide – copper electroluminophors, maximum brightness was associated



(a) (b)

Fig. 1. Electroluminescent crystal of zinc sulphide activated with copper. (a) Between crossed nicols; (b) electroluminescence under 10 kc./s. Magnification, × 60

with a high degree of stacking disorder, as revealed by diffuseness in certain X-ray powder reflexions, and by single-crystal photographs of the constituent crystallites.

These observations may be explained by a non-uniform distribution of emitting centres or by a non-uniform electric field. In either case, the non-uniformity could be due to disordered regions, possibly because activator atoms diffuse readily along disorder boundaries. In this connexion it may be noted that some of the crystals which displayed blue electroluminescent streaks also luminesce under ultra-violet excitation. The ultra-violet luminescence is apparently distributed evenly throughout the body of the crystal, so that the centres involved are uniformly distributed. This perhaps supports the second possibility, although it is not certain that the luminescence originates at the same centres in the two cases.

Although disorder may not be a necessary condition for electroluminescence, particularly as both cubic and hexagonal electroluminescent zinc sulphide phosphors have been reported[3], these results suggest that a suitable environment of copper activator, such as is provided by boundaries between ordered regions of zinc sulphide, can provide conditions particularly favourable for electroluminescence.

It is perhaps significant that silicon carbide also possesses the dual properties of electroluminescence[4] and one-dimensional disorder[1].

The work is being continued and further results should help to assess the influence of crystal structure on the solid-state properties of zinc sulphide.

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[1] Strock, L. W., and Brophy, V. A., *Amer. Mineral.*, **40**, 94 (1955).
[2] Butler, K. H., and Waymouth, J. F., *Brit. J. App. Phys.*, **4**, S.33 (1955).
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[5] Hunt, B. E., and McKeag, A. H., Brit. Pat. App. No. 19242/53.
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Empirical Relationship between the Excitation Energy of the *F*-band and Physical Constants for Alkali Halides

The excitation energy for a $1s - 2p$ transition in an electron associated with a hydrogen-type impurity embedded in a dielectric medium with high-frequency constant K_0 is

$$\frac{3}{8}\frac{e^2}{K_0 R} \qquad (1)$$

where R is the Bohr radius, 0·529 A.

If R is taken as the radius of cation instead of the Bohr radius, then it is found empirically that the ratio of the excitation energy of the F-band to the expression (1) is close to unity for a large number of alkali halides containing F-centres.

The values of this ratio for various alkali halides are given in Table 1.

Table 1

Salt	LiF	LiCl	NaF	NaCl	NaBr	NaI
Ratio	1·0	1·0	1·12	1·06	1·06	1·08

Salt	KF	KCl	KBr	KI	RbCl	RbBr	CsCl
Ratio	1·24	1·16	1·13	1·17	1·20	1·15	1·64

The reason that the CsCl ratio differs from the other twelve ratios might well be due to its different crystal structure.

Values of R have been taken from Pauling, L., *J. Amer. Chem. Soc.*, **49**, 765 (1927), and those of K_0 from Hojendahl, K., *K. Danske Vidensk. Selskab*, **16**, No. 2 (1938).

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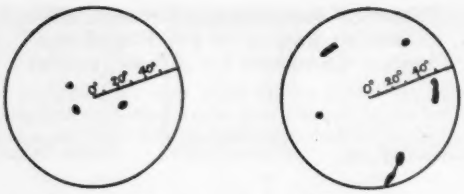
Deformation Characteristics of Hafnium

Because of its high nuclear cross-section, high melting point and good resistance to corrosion and oxidation, hafnium is being considered for practical application in the nuclear engineering field. Appreciable quantities of the material are being produced as a by-product of the production of pure zirconium.

Using small samples sectioned longitudinally from the periphery of hafnium crystal bar, the deformation characteristics of the material were studied. Cracking appeared when the metal was cold rolled 25–30 per cent total reduction. In spite of such precautions as previous vacuum annealing and small passes—1 per cent or less—30 per cent total deformation appeared to be the top limit which could be expected by cold rolling without intermediate annealing. Slightly elevated temperatures, however, seemed to make the material much more plastic. At 500° C., approximately 200° below the recrystallization temperature, the reduction by rolling was found to proceed to almost any practical reduction without cracking. Compression deformation was found to be possible to 90 per cent total reduction at 300° C.

Using a reflexion integrating pole-figure goniometer technique, the orientation of the deformed material after severe etching was studied, and on the basis of preliminary determinations was found to be very similar to the preferred orientations previously reported for titanium[1].



0001 pole figure $10\bar{1}1$ pole figure

Fig. 1. Hafnium of 99·9 per cent purity after 78 per cent compression. Compression axis normal to plots

The compression texture was found to be [0001] rotated 15°–30° from the axis of compression. The basal plane rotation appeared to be predominantly around a $10\bar{1}0$ rotational axis. A typical compression texture of a large-grain crystal bar material is shown in Fig. 1. Each 0001 peak would appear to be due to a single grain.

The rolling texture is very similar with the 0001 plane rotated 10°–25° around a $10\bar{1}0$ rotational axis. Little or no directionality was apparent. In rolling at 500° it was noted that the sample increased considerably in width as well as in the rolling direction, indicating that this deformation may be similar in effect to compression deformation.

This type of texture could be accounted for by $11\bar{2}2$ and $11\bar{2}1$ twinning and $10\bar{1}2$ twinning where the hexagonal axis is rotated from the compression axis and also by $\{0001\}\langle 11\bar{2}0\rangle$ and $\{10\bar{1}1\}\langle 11\bar{2}0\rangle$ slip.

We thank Mr. Roger Sutton, of the Argonne National Laboratory, and Dr. Earl Hayes, of the U.S. Bureau of Mines, for supplying the material used in this investigation, and Dr. Robert Gibney for making available the X-ray diffraction facilities of the Los Alamos Scientific Laboratory.

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[1] Williams, D. N., and Eppelsheimer, D. S., *Trans. Amer. Inst. Min. Met. Eng.*, **194**, 615 (1952).

A Simple Tonometer

An apparatus has recently been developed in connexion with the work of linguists which promises also to be useful to investigators of speech in the deaf. Linguists who study tonal languages such as Chinese and many of the African languages have had in the past to rely almost entirely on the subjective process of listening, in order to determine the all-important pitch of each syllable. The oscillograph is not a practical proposition for dealing with thousands of words. Teachers of the deaf are faced with the fact that intelligibility depends not only on correct enunciation and rhythm, but also on the rise and fall of the voice. The latter accomplishment has proved too difficult save for the more gifted pupils, as it has been undemonstrable.

The tonometer I describe would appear to provide assistance to both these classes. It consists of three units—a microphone, an amplifier, and the tonometer itself. The two principles governing the apparatus are the sympathetic vibration of reeds, and the selective vibration of reeds. It consists of three units: the soundboard, the reed-bank and the oscillator. The soundboard is of wood, about 9 in. long and 3 in. wide, pivoted at both ends to allow of free vibration. On it is fixed the reed-bank. This is a metal comb with 66 slots to keep the reeds in position. On the rear side is a row of retaining screws to hold the back ends of the reeds. These have a triple suspension: each reed passes between three parallel metal bars running the length of the comb, over the first, under the second and over the third, and so on, the vibrating portion projecting through the teeth of the comb. Between the suspension and the holding screws is a metal bar through which pass the tuning screws, one to each reed. By adjusting these, the vibrating part of the reed is either lengthened or shortened. The reeds are spread over a range of two octaves, which allows for the speech-range of adult male speakers of differing natural pitch. The tuning for treble voices would be similar but higher. The tuning needs to be accurate, the distance between the reeds being 2 vibrations per sec. in the bass and 3–4 vibrations per sec. in the middle and high registers. This fine tuning necessitates a special technique described below.

The oscillator is a simple balanced-armature vibrator, the vibrator itself being coupled to the soundboard, and the oscillator connected to the amplifier.

The tuning was accomplished thus: gramophone records were made giving the pitch of each semitone required. The first reed (say *C*) was tuned from the record by sympathetic vibration, the radiogram loudspeaker circuit being connected to the oscillator. Then *C*♯ in like manner. The three intermediate reeds were tuned like this: when reed *C* was vibrating at maximum amplitude, the next reed above it was tuned to vibrate at half its amplitude, and the middle of the three reeds to about a quarter of its amplitude. The same was now done working backwards from *C*♯. If the behaviour of the reeds was uniform, the semitone was divided with sufficient precision. And so on for all the reeds.

A scale is fixed in front of the reeds giving the name of each semitone, and there are movable pointers to assist in plotting the moving reeds during speech.

When a person speaks, only those reeds (and their immediate neighbours) vibrate, the frequency of which is that of the sound produced by the speaker. Thus waves of movement are seen on the reed-bank and it is quite easy to watch the rise and fall of the voice. It is also easy to train oneself to reproduce on the reed-bank a given rise and fall demonstrated by another speaker.

It will be seen that here is an apparatus giving linguists an objective reading for speech intonation: it is also a means whereby teachers of the deaf can show by their own speech (for example, saying 'Good morning') how the voice should rise and fall, noting on the scale the appropriate intervals. Deaf pupils can practice until they produce on the tonometer the same intervals. They will thus be enabled to achieve that correct rise and fall of the voice which is essential to intelligible speech.

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Nov. 5.

FORTHCOMING EVENTS

(Meetings marked with an asterisk • are open to the public)

Monday, February 6

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. W. W. Williams: "An East Coast Survey".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "What should be our National Fuel Policy?" Opening Speaker: Mr. E. F. Schumacher.

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Capt. H. F. Jackson: Presidential Address.

UNIVERSITY COLLEGE LONDON (in the Chemistry Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. K. Alder (Cologne): "Some Recent Aspects of Diene Synthesis".•

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—Meeting on "Cost Accounting in the Chemical Industry".

Tuesday, February 7

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. R. P. Fraser and Mr. P. Eisenklam: "Liquid Atomization and the Drop Size of Sprays".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. A. R. Thomas: "Some Hydraulic Investigations in Connexion with the Wadi Tharthar Project, Iraq".

PHYSICAL SOCIETY, ACOUSTICS GROUP (at the British Institute of Recorded Sound, 38 Russell Square, London, W.C.1), at 5.30 p.m.—Dr. W. H. George: "Determination of Tone-Colour".•

SCIENTIFIC FILM ASSOCIATION (at the Science Museum, South Kensington, London, S.W.7), at 6.30 p.m.—Dr. J. C. G. Gilbert: "Physics and Underwater Research".•

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Prof. H. W. Melville: "A Study of the Chemistry of Radical Reactions by Radioactive Tracer Techniques"

Wednesday, February 8

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO AND TELE COMMUNICATION SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. E. M. Deloraine: "Pulse Techniques, with particular reference to Line and Radio Communication".

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGY GROUP (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 6.15 p.m.—Mr. W. D. Burnet: "The Manufacture of Whisky".

Thursday, February 9

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1) at 4.30 p.m.—Dr. T. F. Macrae: "The Research Work of Glaxo Laboratories Ltd.".

SOCIETY OF INSTRUMENT TECHNOLOGY, CONTROL SECTION (at Manson House, Portland Place, London, W.1), at 6 p.m.—Annual General Meeting. Prof. A. Tustin: "The Scope for Feedback Control and Automatic Calculation in Industrial Mechanization".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. L. G. Fairhurst: "Propellers for Military and Civil Aircraft".

Thursday, February 9—Friday, February 10

SOCIETY OF CHEMICAL INDUSTRY, FOOD, AND OILS AND FATS GROUPS (at the Wellcome Research Institute, 183 Euston Road, London, N.W.1)—Joint Conference on "Recent Advances in the Knowledge and Uses of Phospholipids in Foods".

Friday, February 10

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Anniversary Meeting followed by Annual General Meeting

BRITISH PSYCHOLOGICAL SOCIETY, SOCIAL PSYCHOLOGY SECTION (in the Electrical Lecture Room, University College, Gower Street, London, W.C.1), at 7.30 p.m.—Mr. C. Slaughter: "Some Psychological Implications of an Anthropological Community Study in England".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. J. F. Baker: "The Steel Skeleton".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PRINCIPAL SCIENTIFIC OFFICER (with a second-class honours degree or equivalent in chemistry or chemical engineering, and a knowledge of physical chemistry and of the aspects of physics and mathematics required for the analysis of chemical engineering problems) in the Research and Development Branch, Risley, near Warrington, Lancs, to take charge of a small group engaged on theoretical studies relating to the design and performance of chemical and process plant—The Recruitment Officer, United Kingdom Atomic Energy Authority, Industrial Group H.Q., Risley, near Warrington (February 10).

ASSISTANT LECTURERS OR LECTURERS (2) IN THE DEPARTMENT OF PHYSIOLOGY—The Registrar, The University, Liverpool (February 11).

LECTURER IN EDUCATION—The Registrar, The University, Reading (February 18).

ASSISTANT LECTURER IN ZOOLOGY—The Principal, Royal Holloway College, Englefield Green, Surrey (February 20).

DEPUTY DIRECTOR (with a degree in mechanical or chemical engineering and long experience in a research laboratory in a position of responsibility, and a knowledge of estimation, erection and operation of plants and machineries (including pilot plants)) OF THE FUEL RESEARCH INSTITUTE, Council of Scientific and Industrial Research, India—High Commission of India, Establishment Department, Aldwych, London, W.C.2, quoting 4/98A. (February 20).

SENIOR LECTURER IN PSYCHIATRY—The Registrar, The University, Manchester (February 20).

LECTURER (preferably with experience and research interests in statistical mechanics and thermodynamics) IN THEORETICAL CHEMISTRY in the Department of Physical and Inorganic Chemistry—The Registrar, The University, Bristol 8 (February 22).

LECTURER IN THE DEPARTMENT OF PATHOLOGY—The Secretary, The University, Edinburgh (February 25).

LECTURER or ASSISTANT LECTURER IN PHYSICS—The Registrar, The University, Leeds 2 (February 28).

CHEMISTS and a BACTERIOLOGIST, for dairy laboratory work in New Zealand—The High Commissioner for New Zealand, 415 Strand, London, W.C.2, quoting A.3/4/47 (February 29).

LECTURER IN PLANT PHYSIOLOGY at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, February 29).

LECTURER (preferably with research interest in semi-conductors) IN PHYSICS—The Registrar, The University, Nottingham (February 29).

LECTURER (preferably with special qualifications in ultra-high frequency techniques) IN ELECTRICAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (February 29).

OFFICIAL FELLOW IN MATHEMATICS—The Warden, New College, Oxford (February 29).

PROFESSOR OF NUCLEAR PHYSICS—The Dean, Faculty of Science, Giza, Egypt (February 29).

ASSISTANT EXPERIMENTAL OFFICER (preferably with a degree in botany or agricultural botany) IN THE PLANT PATHOLOGY DEPARTMENT, for work on cereal diseases—The Secretary, Rothamsted Experimental Station, Harpenden, Herts, quoting Ref. 109 (March 1).

ASSISTANT LECTURER (with a special or honours degree in geology) IN GEOLOGY (Palæontology), and an ASSISTANT LECTURER (with a special or honours degree in mathematics) IN MATHEMATICS (including Geometry)—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1 (March 1).

PROFESSOR OF INORGANIC CHEMICAL TECHNOLOGY—The Dean, Faculty of Engineering, Cairo University, Giza, Egypt (March 1).

LECTURER or ASSISTANT LECTURER IN MATHEMATICAL STATISTICS—The Registrar, The University, Manchester 13 (March 10).

ASSISTANT LECTURER or LECTURER IN MATHEMATICAL STATISTICS in the Department of Applied Mathematics—The Registrar, The University, Liverpool (March 12).

LECTURERS (3) IN GEOLOGY—Secretary of University Court, The University, Glasgow (March 12).

CHAIR OF PHYSICS—The Secretary, The University, Exeter (March 15)

LECTURER IN MICROBIOLOGY—The Registrar, The University, Reading (March 24).

CHAIR OF PHYSICAL CHEMISTRY at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, March 26).

CHAIR OF PHYSICS at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (March 31).

DIRECTOR (with a wide knowledge of plant pathology (particularly of tropical crops) and experience in research of the subject, administrative ability and experience, literary taste, and some knowledge of languages) OF THE COMMONWEALTH MYCOLOGICAL INSTITUTE, Kew—The Secretary, Commonwealth Agricultural Bureaux, Farnham Royal, Bucks (May 31).

ASSISTANT CONSERVATOR (with a university degree in forestry) OF FORESTS, Sierra Leone—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.61/15/04.

CHEMIST (with a first- or second-class honours degree in chemistry or equivalent qualification and at least three years postgraduate research experience) with the Ministry of Supply at Farnborough, Hants, to take charge of a laboratory engaged in research and development work on textiles in relation to their use in Service equipment and clothing—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F 37/6A/AA.

CHIEF LABORATORY TECHNICIAN IN THE PHYSICS DEPARTMENT—The Secretary, Northern Polytechnic, Holloway, London, N.7.

DEMONSTRATORS IN PHYSICS and DEMONSTRATORS IN ORGANIC CHEMISTRY—The Registrar, The University, Nottingham.

EXPERIMENTAL OFFICER (preferably with a degree in physics or mathematics and previous laboratory experience, or at least H.S.C. in science subjects or equivalent) IN THE NUCLEAR PHYSICS DIVISION, to take charge of the construction and operation of a neutron velocity selector for the new research reactor Dido—The Establishments Officer, U.K. Atomic Energy Authority, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 474.

EXPERIMENTAL OFFICER (with at least H.S.C. in science subjects or equivalent qualifications, a good general knowledge of physics with some idea of the basic concepts of nuclear physics, and preferably with several years experience in a physics laboratory) IN THE

NUCLEAR PHYSICS DIVISION, to help organize a small team working on the measurement of neutron spectra in reactors—The Director, Atomic Energy Research Establishment (Recruitment), Harwell, Didcot, Berks, quoting 484.

INSTRUCTOR, ASSISTANT PROFESSOR or LECTURER (preferably with a doctorate in physics or mathematics, and an interest in nuclear or solid state physics) IN PHYSICS—The Chairman, Department of Physics, Western Reserve University, Cleveland 6, Ohio, U.S.A.

LECTURER IN AGRICULTURAL CHEMISTRY—The Principal, Shuttleworth College, Old Warden Park, Biggleswade, Beds.

METALLURGIST (with a first- or second-class honours degree or equivalent qualification in metallurgy, and several years metallurgical research experience, preferably in the field of non-ferrous metals) at a Ministry of Supply Establishment at present in S.E. London, for research and development in the field of less common non-ferrous metals—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.18/6A/AA.

PHYSICISTS and ELECTRICAL ENGINEERS (with a first- or second-class honours degree or equivalent in physics or electrical engineering) at the Ministry of Supply Radar Research Establishment, Malvern, Worcs, for research and development work, mainly on radar and electronic equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.490/5A/AA.

PRINCIPAL LECTURER (with high academic qualifications, and preferably some industrial experience) IN FOOD SCIENCE—The Secretary-Treasurer, Royal Technical College, George Street, Glasgow, C.1.

PROFESSORS (with a post-graduate degree or diploma and considerable teaching experience) OF ANATOMY, PHYSIOLOGY, and PHARMACOLOGY, at a new Medical College to be established at Chittagong, East Bengal—The Recruitment Officer, Education Division, Pakistan High Commission, 39 Lowndes Square, London, S.W.1.

RADIOGRAPHER IN THE X-RAY DIAGNOSTIC DEPARTMENT—The House Governor, Westminster Hospital, St. John's Gardens, London, S.W.1.

SCIENTIFIC OFFICERS (with at least a second-class honours degree in chemistry or equivalent qualifications) and EXPERIMENTAL OFFICERS (with H.S.C. in science subjects, including chemistry or equivalent qualifications, together with some experience in inorganic chemistry or analysis), to work on the development of methods for carrying out special inorganic chemical preparations and of techniques for depositing thin films by a variety of physical and chemical procedures—Establishments Officer, U.K. Atomic Energy Authority, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting reference 472

SENIOR LECTURER IN METALLURGY; ASSISTANT, Grade B, IN MECHANICAL ENGINEERING; and ASSISTANTS, Grade A, IN (*a*) CHEMISTRY and (*b*) STRUCTURAL ENGINEERING, at Constantine Technical College—The Director of Education, Woodlands Road, Middlesbrough.

SENIOR METALLURGIST, Principal Scientific Officer or Senior Scientific Officer grade (with a first- or second-class honours degree in metallurgy or equivalent qualification, preferably with experience of failure investigations, a good knowledge of metallography and at least three years postgraduate research experience), at the Royal Aircraft Establishment, Farnborough, Hants, for metallurgical investigations of failures and defects in aircraft parts, and to take part in the metallurgical research of the department—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.12/6A/AA.

SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics, and at least three years postgraduate practical experience of electronics with the ability to apply it to research problems) to lead a small team engaged on novel physical research problems involving the techniques of mass spectrometry and radioactive measurements—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 1001/34.

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